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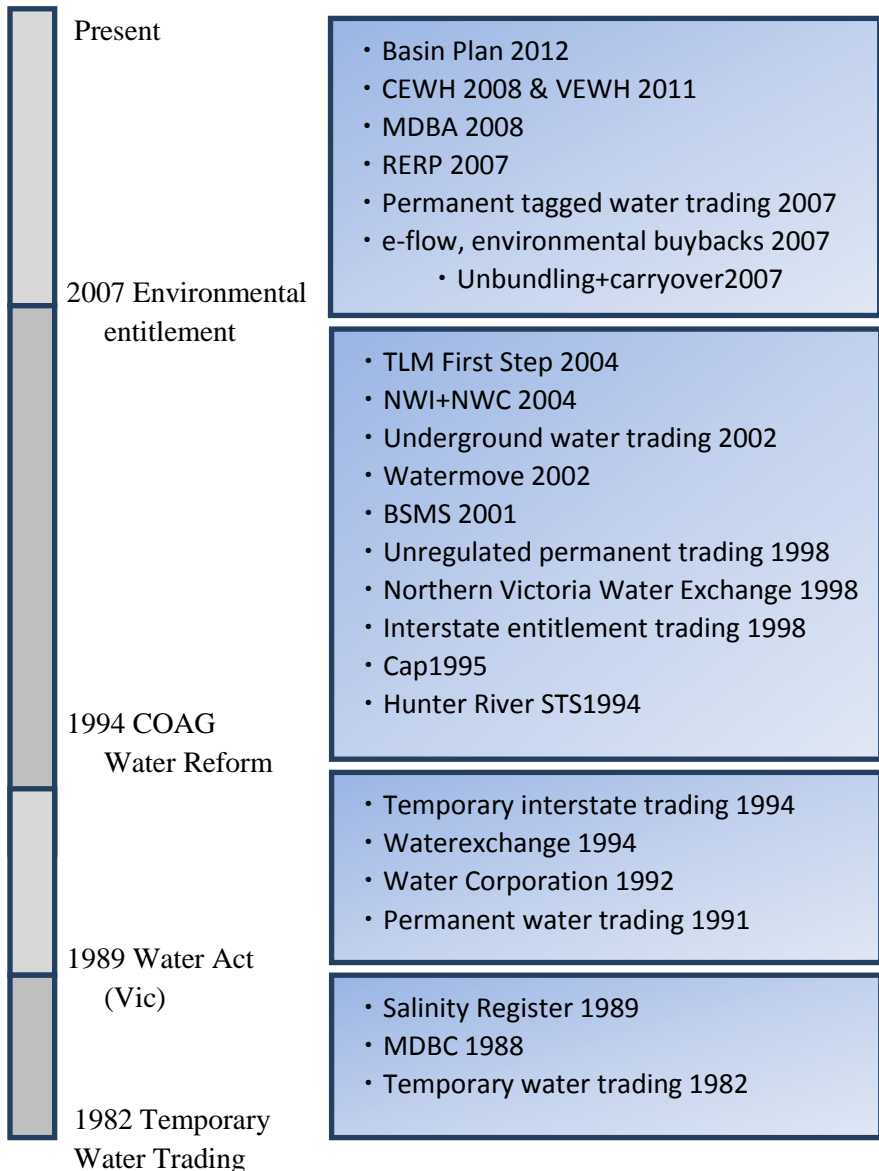
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Development of Water Market in Australia



Chapter 1

Introduction to Australia's water markets

Section 1: Introduction and composition of this book

A water market (or water trading) is a new method of water resources management which is based on the use of incentives. It means trading in water resources (i.e. water converted into a state which can be governed) as economic goods. Because many water resources are not solid and stable, they cannot be directly governed as usual goods – therefore the right to use water is traded. Water market may also mean the state of the resource allocation attained through these dealings.

Water trading is a more general term than water market. It is a concept that includes transaction negotiations by concerned parties without using a market, and water dealings by auction. The special feature common to water markets and water trading is the transfer of money.

Although water markets or water trading have been performed formally since around the 1960s in the western United States (the Oregon Water Trust), and took place secretly in Australia during the drought of the 1940s, the beginning of the 1980s saw it accepted as a lawful dealing in Australia. It gained attention as a new market technique for performing the distribution and quality control of water resources (emission

rights trading) and is now used in the Netherlands, the UK, Switzerland, Spain, Canada, Chile, Mexico, Brazil, the Middle East (including Saudi Arabia), Tanzania, South Africa, northern India, Pakistan and China and other places. (Field, 2001, p.161; World Bank, 1992, pp.55–61; Turpie *et al*, 2005, p.67; Easter *et al*, 1998, pp.8-14; Grafton *et al*, 2011, p.219; Hanak *et al*, 2012, p.19; Sun *et al*, 2010).

There is nothing new about a water market if it is viewed from the point of economic theory and the outstanding resource allocation of the general market economy is applied to water resources management. However, as the target of the resource allocation is water the big issue is that it is a good which has not traditionally been considered as an object of private property because of the difficulty of managing it. A water market has a relationship with global warming and is attracting interest also as a factor in water-shortage problems in many part of the world. Moreover, the discharged water market (emission rights trading) has been attracting new attention theoretically and practically as an applicable example of the Coase theorem which: supposes that an environmental problem is solvable by setting a private property right to the externality accompanying a production activity, and by the free negotiation of the parties concerned.

The Australian water market can be considered the most successful example in the world in that it is large-scale, refined

and completely used as a means of water resources management. For example, according to Hanak *et al.*, 2012, p.19, the annual volume of water committed for sales or lease was more than two million acre-feet (about 2466gl) in 2012 in California's water market, but in Australia (mainly in the Murray-Darling Basin; MDB), it was about 4697gl in 2010-11 (see Table 1.6).

The fundamental purpose of this book is to show clearly why Australia was able to succeed in introducing the water market, and the extent of influence water resources management has had on society. It also shows the relevance of the Australian experience for the sustainability of the broader modern society.

Although the main thrust of this book is economic, we think its content is relevant to many other people such as executive officials, economic researchers, lawyers, politicians and environmentalists involved in water resources management. It shows how the experiences and lessons of Australia could be as a standard model applicable anywhere in the world, including Japan.

This book consists of fourteen chapters divided into three parts except for Chapter 1.

Chapter 1 discusses the fundamental research targets of the Australian water market and their position in water reform. It outlines the historical progress of water reform and a water market, such as resources in the MDB, irrigation agriculture and

the current state of the water market. This introduction shows the concerns expressed elsewhere in the book.

Part I, which consists of Chapters 2 to 5 analyses the methodical problem and delves into the basic concept of economics to explain its development as an indispensable tool in the analysis of water markets, such as a water demand curve and a water supply curve. This will enable readers unfamiliar with economics to understand an economic analytical tool.

Part II (Chapters 6 through 11) is a central portion of the book, dividing water reform into three subsystems with an investigation of each. Legal aspects are treated first followed by examination of the original water market reform including industry and pricing reform and finally the reform of an environment policy. Part II shows clearly the problems faced by the Australian water market and how it broke through those difficulties. In particular, it shows how reservation of water for environmental reasons equates with the Coase theorem.

Part III (Chapters 12 through 14) analyses the short-term and long-term consequences on the Australian water market from aspects of the economy, society and environment. An original method was developed for measuring the economic surplus of a water market and the size of the economic surplus of a water market was analysed for the first time in the world. As a result, it became clear that there exist big economical benefits in

Australia. The final chapter (Chapter 14) answers the key questions and problems raised in Chapter 1 and reviews these issues in the light of experience and the lessons learnt in Australia.

Section 2, which follows, introduces the research task described above and outlines the water reform and water market reform in Australia.

Section 2: An outline of Australia's water reform

1.2.1 A dual viewpoint analysing water reform

Australian water market reform can be positioned within the framework of current water reform. It is thought that water market reform had a big influence socially and could have been successful simply because it was interlocked with wider water reform. We would therefore like to begin our explanation against the background of this water reform.

Water reform replaces an approach to water resources management centred on conventional command and control with management focussed on market-based instruments as a whole, and includes radically reforming the conventional social system of water resource management. Water reform includes reform of not only issues directly connected with a water market, but also the various factors relevant to it, such as the legal, administrative, political, institutional, economic, environmental and ideological aspects. It is the antithesis to conventional water resources management systems, which inclined towards supply management and excessive economic growth.

It is thought that the 1990s were when reform of various systems of the conventional water resources management took shape globally (Smith, 2003, p.65). For example, the United Nations Earth Summit (a global environment meeting) was held in 1992, dam withdrawal (with the withdrawal of Elwha Dam)

started in the United States in 1992, and the CAP system which aims at suppressing water use of each state to the 1994 level of usage was introduced in Australia in 1995. In Japan in 1997 the River Law, a fundamental act of water development, was greatly revised in its direction regarding the environment, and a freeze on and re-examination of dam construction started after this. It was also in the 1990s that a 'near natural' construction method was adopted by the river improvement enterprise in Germany.

In looking at how the water resources management reform is transmitted globally, Smith raised the following dual viewpoint on water in human history and the modernisation of Australia, quoting Falkenmark and Lindh (1993) (Smith, 2003, p.54).

The first viewpoint positions the relationship between water and human beings:

The first step: the time of pre-industrial society – water was a heavenly blessing and people's access to water was easy.

The second step: the time of positive exploitation of water resources after industrialisation – hydroelectric dam construction and construction of irrigation dams for water flow regulation took place along with the movement of water out of valleys. This coincided with rapid socio-economic development of the community and the growth of cities and farming villages. The time/spatial re-allocation of water resources was performed by civil engineering techniques.

The third step: the time of maturity –in the main river basins, control of the flow approached the maximal level and the marginal cost for further water development quickly increased. In order to raise the supply capability of water resources, concern about non-traditional methods increased. Smith has indicated that the Murray–Darling Basin and the Perth area in Australia have just entered this third period of maturity.

The second viewpoint positions the development and conversion of today's water management in relation to the modernisation of Australia (the 240–year period including the inauguration of the federal system):

The first term: 1770 to 1901 – the start of the federal system of government and a time of challenge and adaptation.

The second term: 1901 to 1945 – advance of the integration of a federal state and a time of the irrigation settlement.

The third term: 1945 to the end of the 1980s – a period of economic growth and dam construction.

The fourth term: after the end of the 1980s – a search for alternatives.

Looking at it from this model, on-going water reform is recognised as being at the third stage in terms of human history, and in the fourth stage in terms of modern Australia, and in a state of massive change in which the wave motion of these two reforms resonate and overlap. In the remaining portion of

Section 2, water reform in Australia is historically surveyed from the viewpoint of changes to water resources management from Smith's dual viewpoint.

1.2.2: Changes in water resources management in Australia

The first term: 1770 to 1901. A time of challenge and adaptation.

Europeans attempt bold civil engineering to adapt to the strange weather environment in a dry land. Notable developments include the discovery of the Great Artesian Basin, the early development of this basin, and the construction of a pipeline to Kalgoorlie and the Eastern Goldfields from Mundaring in the suburbs of Perth. The possibility of irrigation agriculture was gradually recognised. Although the Chaffey brothers began a famous irrigation enterprise near Mildura early in the 1890s, this adventurous trial ended in bankruptcy in 1895 (Smith, 2003, p.58).

The second term: 1901 to 1945. Advance of integration as a federal state, and a time of the irrigation settlement.

In the process of establishing the federal government, each state's rights to the water of the Murray-Darling Basin was clarified and the River Murray Water Agreement was introduced in 1915. This led to the formation of water organisations in each state were formed and a start being made on building a series of weirs along the River Murray in each state was started, initially

to transport goods but progressively to allow diversion of water for irrigation. These public institutions gave the financial backing for water infrastructure construction. There was an optimistic feeling of infinite expansion which was supported by large scale settlement in the rural areas by returned soldiers. The development of capital-intensive agriculture was remarkable in a time of two world wars sandwiching the Depression era.

The third term: 1945 to the end of the 1980s. A time of economic growth and dam construction.

Although in the first and second terms irrigation was considered the compelling force for development and future agricultural output, the size of the development was nothing compared with the 30 years after the 1950s which saw the construction of dams equivalent to 75 per cent of the pondage of present Australia and, if we include the 1980s, this ratio is 90 per cent. (However, many of the dams built in the 1980s were planned or permitted in the 1970s. Therefore, it can be said in the 1980s that movement towards planning of new dams came to stop). The storage capacity of the dams built in the 1950s was equal to all the dam capacity built before then, and large-sized dams and multipurpose dams were praised. The Snowy Mountain Scheme, which was started in 1949 and was completed in 1974, symbolises this period. It consisted of sixteen major dams, seven power stations, a pumping station and

225 kilometres of tunnels, pipelines and aqueducts. In the same era a series of water-power generation councils known as the Hydro-Electric Commission (HEC) constructed a large dam in Tasmania, Western Australia's Ord dam was completed in 1972 and Queensland's Burdekin dam (called 'the last large-sized dam') was completed in 1987.

The unprecedented postwar expansion was promoted by the further development of civil engineering technology and aided by the federal government pouring in powerful financial support. In addition, each state government administered public subsidies for water development.

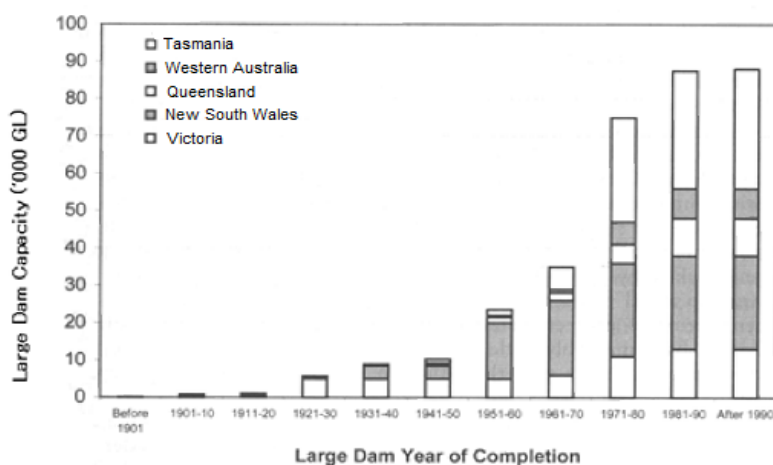


Figure 1.1: storage capacity per state by construction of large dams

(100gl or more): 1901 to mid-1990s

(Source: Smith, 2003, p.59, partly modified)

The fourth term: After the end of the 1980s. The time of looking for alternatives.

Until the end of the 1980s there was not much concern about Australia's water management plan (Smith, 2003, p.54). It is said that the reason is because people believed the following five myths:

- (1) Water is a heavenly blessing.
- (2) It is possible to detach water (from nature) and to manage it separately.
- (3) It is possible to change a desert into a garden of flowers.
- (4) Social value (i.e. lifestyle of water consumption) is eternal.
- (5) Water management is mainly a technical problem.

In 1985, no comprehensive water management plan existed on any state, territory or federal government level (Smith, 2003, p.54). However, after the 1980s, the more rational approach to a global economic policy, i.e. that a user should naturally pay the cost spread, was accepted in Australia. This view had an important influence on water resources management: in that there was a change from a supply-leading approach to a limited-supply viewpoint. Before the end of the 1980s, it was difficult to evaluate future water demand based on the increase in

population, or to predict the continuous increase in the annual amount of the water used. Moreover, enterprise cost and the problem of water price were disregarded and reducing water demand by using water efficiently was not taken into consideration.

Signs of change began to bud in the early 1980s, albeit slowly at first. The federal government published a series of reports summarised as ‘Water 2000’ (DRE, 1983). However, the reaction of parliament to the proposals was minimal.

When the HEC (the Hydro Electric Commission of Tasmania) proposed construction of a large dam in an area including the Franklin River the dam became an important environmental cause (Kondo, 1995a, pp.49–53). At the end of 1981 a Tasmanian referendum supporting the dam’s construction was held in Tasmania. Opposition, concerned about environmental deterioration, spread to the mainland and the federal government under Malcolm Fraser moved to register the southwest of Tasmania as a world heritage site. After the federal election of March 1983 the new Hawke government took the Tasmania government to the High Court of Australia to stop the dam’s construction.

Importantly, the activism did not stop after the construction of the Franklin dam was prevented. The environmental lobby became an actual entity that today affects the highest levels of

political decision-making. A national strategy for ecologically sustainable development, supported by government organisations at all levels, was developed in 1992 following the report of the United Nations' World Commission on Environment and Development (WCED) in 1987 (*Our Common Future*, WECD, United Nations 1987), and official recognition was given to the existence of water as an environmental problem (see 1.2.3).

The citizens' participation movement concerning the environment expanded greatly during 1980s. They advocated involving the community in planning and decision-making, and a bottom-up process. For example, the state of Victoria's program against salinity, introduced in the mid-1980's, discarded the traditional bureaucratic process in order to recognise the community-led move against salinity. The community working group (eventually it became to number about 400 members) received technical assistance and a representative group of farmers was heavily involved in planning with every farmer given the opportunity to comment on the draft plan prepared. This program against salinity was also a part of Landcare, Victoria's comprehensive nature conservation program. Landcare was used to form a national undertaking in July 1989 and spread out into a still bigger grassroots movement that has now expanded to 4000 or so local

groups. Landcare successfully lobbied the Hawke Labor Government to commit itself to the emerging movement and became a national program in July 1989 when the Australian Government announced its Decade of Landcare Plan and committed A\$320 million to fund a national Landcare program. Today Landcare serves internationally as a model of community inclusion (Smith, 2003, p.61).

Increase in resident concern and civil movements such as Landcare suggest that water must never be considered in isolation, and emphasises the importance of considering the whole drainage basin where land and water resources are connected.

1.2.3: ESD Process and Council of Australian Governments (COAG) Water Reform

The reform of conventional water resources management that started in the early 1980s was accelerated in response to the publication of *Our Common Future* by the WCED in 1987, which was deployed not only globally, but also in Australia in the 1990s (Harding, 2006, p.233).

The factors which led the reform process of this natural-resources management (including water trading) especially were adoption of the ecologically sustainable development (ESD) policy by the federal government in 1992, and the subsequent

declaration by COAG (Council of Australian Governments) of water reform in 1994. When raising reform from state to federal level, these factors played an important and decisive role (refer to Chapter 8, Section 3, and Chapter 9, Section 2, for the development of the environment policy of Australia after the 1990s including the COAG reforms).

The ESD process provided detailed specifications for national reform of each industry and appealed for continuous community cooperation in building a sustainable society in line with national targets and principles. A partial definition of ESD is:

‘Using, conserving and enhancing the community’s resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased ... More practically, ESD will mean changes to our patterns of resource use, including improvements in the quality of our air, land and water, and in the development of new, environmentally friendly products and processes.’ (Source: <http://www.environment.gov.au/about/esd/publications/strategy/intro.html>, accessed 30 October 2012).

The guiding principles are:

- Precautionary principle: where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for

postponing measures to prevent environmental degradation

- Develop a strong economy: the need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognised
- Enhanced international competitiveness: the need to maintain and enhance international competitiveness in an environmentally sound manner should be recognised
- Improved valuation, pricing and incentive mechanism: cost effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms. (Source: <http://www.environment.gov.au/about/esd/publications/strategy/water.html>, accessed 30 October 2012, partly modified).

Water resources management, the promotion of integrated catchment management, the establishment of a water pricing system in consideration of environmental externalities, the reform of transferable water entitlements, the development of a water market and the institutional reform of water agency were shown as a single subject for which governments will:

- continue to encourage and support actions to develop and adopt an integrated catchment management approach to water resources
- continue to develop methodologies for the determination of environmental externalities into water pricing
- encourage more rapid adoption of water pricing structure, including where appropriate, complete pay-for-use tariff
- focus on improving water markets and mechanisms for introducing more comprehensive systems of transferable water entitlements
- continue to pursue institutional reform of water agencies.

(Source:

<http://www.environment.gov.au/about/esd/publications/strategy/water.html>, accessed 30 October 2012.)

COAG is a coordinating body peculiar to Australia, where states are powerful. It facilitates communication by helping the federal government and state governments to coordinate and cooperate on a national subject. In order for the federal government to attain its goal, it has to appeal to state governments for cooperation by using a strong subsidy. With state governments and the federal government obliged to cooperate, it can be said to be the most powerful administration device in Australia.

COAG released its Water Reform Framework in February 1994

in response to the national strategy formulated in 1992 and the Hilmer committee report on the national competition policy published in August 1993. This framework became a basic statement document which specified water reform for Australia at large.

COAG requires that a water price should be set up based on full cost recovery, and that water rights (property rights for water) should be made transferable according to Hilmer's advice about water markets (COAGWRTF, 1995). It states:

- All consumptive and non-consumptive water entitlements [should] be allocated and managed in accordance with comprehensive planning systems and based on full basin-wide hydrologic assessment of the resource.
- Water entitlements and institutional arrangements [should] be structured so as not to impede the effective operation of water markets and such that, as far as practicable, trading options associated with property rights in water reside with the individual end-users of water.
- Water entitlements [should be] clearly specified in terms of:
 - rights and conditions of ownership tenure;
 - share of the natural resource being allocated (including the probability of occurrence);

- details of agreed standards of any commercial services to be delivered;
- constraints to and rules of transferability; and
- constraints to resource use or access.
- Acceptable rules on the holding and trading of environmental flow entitlements [should] be resolved by jurisdictions at the same time as determining the appropriate balance between consumptive and non-consumptive uses of water;
- Where inter-state trading of water entitlements is possible, jurisdictions [should] cooperatively develop on a catchment basis compatible approaches for (or at least clear conversion mechanisms between):
 - planning systems and basin-wide hydrologic assessment methods;
 - pricing and asset valuation arrangements;
 - water entitlement trading arrangements; and
 - provision for environmental and other in-stream values.
- In implementing and initialising property rights in water, jurisdictions [should] call on water users, interest groups and the general community to be involved as partners in catchment planning process that affect the future allocation and management of water entitlements.

- Governments [should] give urgent priority to establishing the regulatory arrangements that are necessary to implement and support the strategic framework. (COAGWRTF, 1995, partly modified).

The general effect of COAG's water reform is a 'policy intention which asks for the solution of a price base and a market base to an environmental problem' (Quiggin, 2001, p.76). Especially in irrigation sectors, these reforms may greatly contribute to the increase in efficiency for water supplies and may promote biodiversity by increasing the environmental flow. However, a clear conflict of interest existed among users.

For example, Smith called people's attention to the fact that it is necessary to think more about whether the COAG principle should be widely applied to various problems, quoting the report of the technology academy AATSE (1999). He said that more attention should be paid to the problem of the externality of the contamination especially caused by agriculture. Moreover, he called for more attention to be paid to the public regulation of corporate business, criticising the excessive privatisation as follows:

'The recommendations in the AATSE (1999) report draw attention to many matters that need further attention if the COAG principles are to be widely adopted. Among these are the

need for much more attention to water quality, especially the costing of the externalities of pollution that are caused by industry, including agriculture ... Critical issues that need attention are those of regulatory mechanisms and institutions to control corporatised, franchised and privatised components of the water industry. It is difficult to resolve community involvement with these concepts, and well-resourced government watchdogs are required, as is the case with the privatised water industry in Great Britain' (Smith, 2003, p.64).

All the time it is subject to the political tug of war between the federal government and state governments, water reform under COAG will show various fluctuations, with economic rationalism on one side and environmental principles on the other side (refer to Chapter 9 and Chapter 11 for the motion after 1990s).

1.2.4: Institutional change by economic rationalism (corporatisation)

Although it is said that water policy change in Australia for the last ten years of the 20th century has exceeded what came before that, this is especially applied to institutional change (Smith, 2003, p.61). Both the governing party and the opposition parties approved the incorporation of a water organisation at state level and federal levels. All the state organisations controlling water

for cities and rural areas underwent large-scale reorganisation and were completely reconstructed. The influence of this economic rationalism and commercialisation was widespread. During the 1980s a big water organisation not led by engineers was a rarity; nowadays it is hard to find any that are led by engineers. The water organisation of all states has moved towards corporatisation.

How organisations based on a statute adopt commercial activities can take many forms. In the most extreme cases, it can be called a franchise system – property is owned publicly, but in the set-up period, the management is lent to private enterprises. In Australia, the most remarkable example of this is Adelaide, a state capital that transferred the right of management to an overseas consortium, United Water International (UWI), for 15 years from 1 January 1996.

In public sentiment and media discussion, corporatisation is often confused with privatisation. Privatisation is limited to when a private enterprise owns property, namely, when government property is sold off and shares are bought and sold on the stock market. The Australian government did not participate in the attempt of privatisation. Although it was proposed by some administrations in the ACT, it was rejected in the ACT Legislative Assembly (parliament) at the beginning of 1999 (Smith, 2003, p.62).

In rural NSW, situations differed a little and the state government sold ownership of the irrigation infrastructure, except for the water resources dam. This is considered a form of privatisation. (However, the reality is that a local monopoly cooperative of irrigation farmers has received the fixed regulation of the government).

Other related matters of the corporatisation of Australian water by various governments include:

- 1995. Murray Irrigation Limited was established by NSW Government. Public property was transformed to the cooperative of irrigation farmers, i.e. privatised. (However, the dam assets were excluded).
- 1997. The bounty system to state governments of the federal government called ‘tranche payments’ started. (Up to 2004 the total amount of National Competition Policy (including Water Reform) was A\$3,900 m [Lee *et al.*, 2009, p.10]).
- 1998 Although corporatisation of River Murray Water (RMW) was considered by the Australian Government, eventually it was stopped.
- 2000 SA Water Corporation was established by corporatisation in SA.

1.2.5: Introduction and expansion of water market and trading

Although legal water trading started in Australia in the early 1980s, there are various views about where it first began.

Brennan and Scoccimarro claim it was introduced in SA and NSW in 1983 and in Victoria in 1987, and spread to the rest of the states after that (Brennan and Scoccimarro, 1999, p.73).

MacDonald and Young claim that Victoria and NSW were the first (MacDonald and Young, 2000, p.44). According to Victorian government documents, SA changed legislation in 1983 and permitted temporary and permanent trading (DNRE, 2001, p.99). Moreover, Meyer says temporary and permanent trading has existed in SA since 1982 (Meyer, 2005, p.80). In the National Water Commission's (NWC) 'short history', it is suggested that it began in SA and NSW in 1983 (NWC, 2011a, p.50).

At first, it was temporary trading (now, it is called allocation trading): the right of use was transferred temporarily and, when the use period expired, it was returned to the owner. Permanent trading (namely, transfer of water rights, now called entitlement trading) also came to be performed gradually. For example, in Victoria the Water Act, which allowed permanent trading of water rights, was approved in 1989 and permanent trading started in 1991. For the purposes of this book, we will adopt

1982 as the earliest time of water trading. Chapter 6 discusses reform of water rights in detail.

Although Chapter 3 discusses the theoretical background of water trading in detail, the structure of water trading (i.e. cap and trade) is easy in economic theory. First, the diversion right (or use right) of water is separated from the ownership of land and this is defined as property rights. (The classification and registration of (1) the amount of water, (2) reliability, (3) transferability and (4) quality standards will probably be required.) The maximum for water supplies is decided by a certain political consideration (i.e. the 'cap'). A quantity which can be used, i.e. the water rights, is distributed to each registered user. (Although irrigation farmers are the main registered users, environmental NGOs and local self-governing bodies can also be subjects of trading.) Each user deals in water freely directly or via the independent organisation that handles the water trading (i.e. 'trade'). Unlike emission rights trading of CO₂, the range of dealings for water rights trading is limited to the spatial range connected directly and physically to the fixed waterway.

Water trading is explained using Figure 1.2.

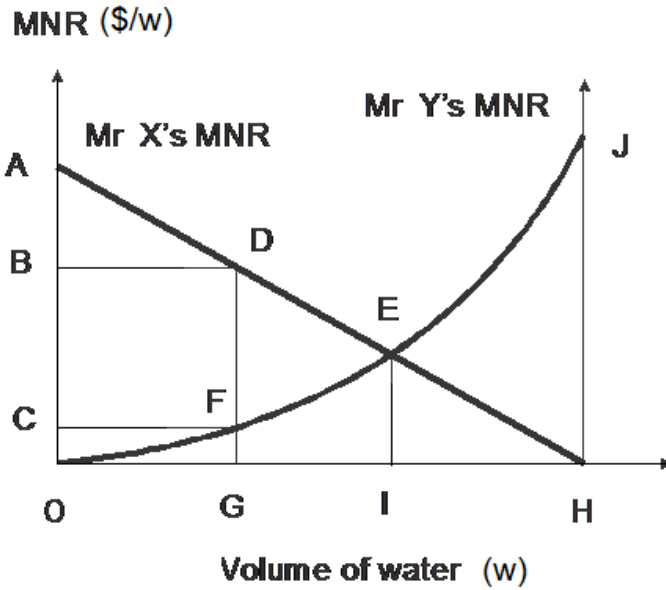


Figure 1.2: structure of water trading

The maximum exploitable water resources is shown by OH, the producer's X amount of water-resource injections is measured on the right from the starting point O on the horizontal axis, and the producer's Y amount of injections is measured leftward from the point H on the horizontal axis. The marginal net return (MNR) curve of Mr X is taken as a downward slant curve to the right, and that of Mr Y is taken as an upward slant curve to the right.

Supposing only OG is distributed to Mr X and only HG to Mr Y at first, this distribution does not have the socially desirable amount of resource allocation. This is because Mr X's marginal productivity (or marginal net return) has exceeded that of Mr Y, and Mr X can make the whole economic merit increase at point G by the amount the injection of water resources is increased (in exchange for reducing it for Mr Y). If Mr X can make allocation of water resources increase only GI, and if Mr Y can decrease only IG, only DEF of total income sum can actually increase. If a water rights market can be introduced and a water price can be set as the level of EI in order to realise these dealings, an economical merit will make Mr X purchase the water of GI, and an economical merit will make Mr Y similarly sell off the water of IG. Because a third party does not need to set up the equilibrium price (EI) for water from the outside, water remainders will occur if it is too high and a water shortage will occur if it is too cheap; an equilibrium price will be automatically attained by the dealings or negotiation inside a market.

Water trading is able to produce the greatest at the minimum expense by independent dealings between the producers from whom marginal productivity differs. Furthermore, it does not need participation or intervention of a public institution like before.

However, there are the following problems:

- Externalities: there are negative (or potential) external effects of changing the consumer price of water (for example, when water rights are purchased from outside the area and much water is thrown into a certain area, the groundwater level may go up and damage from salt water may arise)
- Third party impacts: the problem of reserving water demand at the minimum for maintaining the common property portion and function that river water has (for example, the purification function for downstream people, and maintenance of riverside and biodiversity for residents)
- Reservation of the fairness of initial distribution
- Setting the consumptive use maximum of water resources for humans
- Transaction costs: reducing the management costs of water trading or market
- A market participant's restriction
- Harmonisation of the different water resources management policies for every state in the case of interstate trading.

Figure 1.3 shows the expansion of temporary trading and birth of permanent trading in Victoria for the 11 years from the 1990/91 fiscal year to the 2000/01 fiscal year. Permanent trading started in 1991. Temporary trading increased quickly from the 1994/95 fiscal year and although permanent trading was also slight, it was increasing.

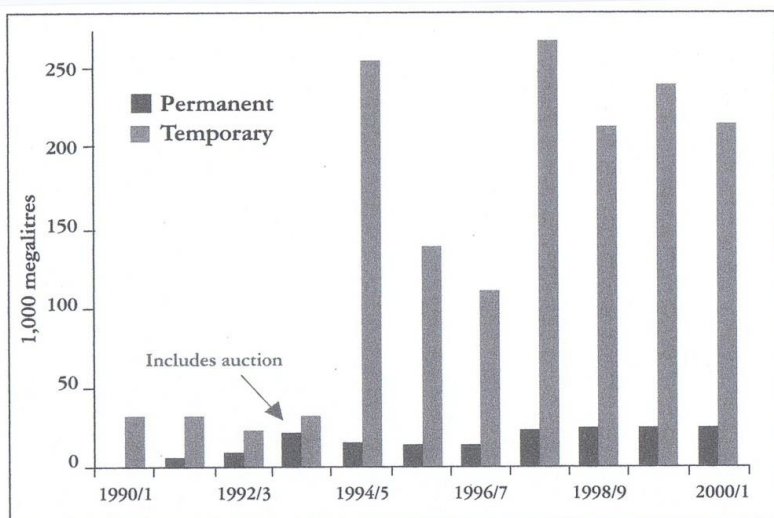


Figure 1.3: birth and expansion of the water market in the State of Victoria: 1990/1–2000/1

(Source: DNRE, 2001a, p.12)

Furthermore, water trading expanded to interstate trading. A pilot enterprise of interstate trading was carried out in the Riverina area in 1998, trading 9.8gl of water between SA and the upper stream, NSW or Victoria (MacDonald and Young,

2000, p.46). When water rights are dealt between the upper stream and the lower stream across states, big negative externalities can occur (or are feared to occur). Although the introduction of Pigovian tax theoretically is a means to take this externality into consideration, with the pilot enterprise of the above-mentioned interstate trading, the exchange rate of the water between SA and an upstream state was made into the water rights of 10ml of SA equal to the water rights of 9ml of Victoria or NSW (MDBC, 2000c). Quiggin explains that it is the introduction of the Pigovian tax which changed the form (Quiggin, 2001, p.90).

In the development of a water market, voices of caution are deep-rooted. Institutional change because of the tendency of the market to exceed a limit may include the qualitative alteration to ‘water distribution for an owner with perfect property rights’ from ‘water distribution for an irrigation farm with a licence’. While this water distribution problem is also connected to the influence of the latest drought or future climate change problems, there is concern as to who pays the cost of the water purchase for environment, or whether the existing water supplies will be reduced (Smith, 2003, p.64).

1.2.6: Development of Integrated Catchment Management

If a water market is seen as a means to make a strong economy, the means for making a strong environment would be integrated catchment management (ICM).

It can be said that in the 1970s an awareness of the importance of reflecting residents' opinions on the plan and management of catchments or basins did not exist. For example, in the United States, it was thought to be 'an unnecessary and excessive thing' to make residents participate in catchment management. However, as it became clear that a top-down system of water resources management and a decision-making system centring on the specialist skills of civil engineering have had a bad influence on the environment, and as that begins to receive residents' criticism, a new motion has taken place in each country (Turner, 2005, p.11).

The view that was called 'watershed planning' in the United States, 'river basin planning' in Britain, and 'landscape planning' in Germany spread, and citizens began to participate in municipal affairs. In Australia, there were changes to the approach of the conventional top-down type (i.e. command and control type), and the importance of the catchment plan (CP) gradually came to be recognised. And gradually, the bottom-up process of the water management system was fixed institutionally. Moreover, the UN Earth Summit in 1992, with

its Agenda 21, became the important cause to change command and control type's water resources management. Citizens' participation in municipal affairs planning at all levels was advocated and such a view was widely accepted in Australia.

In Australia, four levels of integrated catchment management are now performed:

- (1) federal
- (2) state government
- (3) catchment
- (4) sub-catchment.

The Salinity and Natural Heritage Trust program was run at federal level in Australia (including the Murray-Darling Basin), and the necessity for integrated catchment management is incorporated in the following documents:

- Integrated Catchment Management in the Murray-Darling Basin 2001–2010: Delivering a Sustainable Future (MDBC, 2001b).
- Basin Salinity Management Strategy 2001–2015 (MDBC, 2001a).

In addition, MDBC/A (MDBC and MDBA) is responsible for the integrative management of the MDB. This is explained in section 2.7. The catchments of the MDB are shown in Figure 1.4.



Figure 1.4: MDB catchments

(Source: web page of DSEWPC, Australian Government, accessed 17 October 2012).

Next, on the state level, a Catchment Management Authority (CMA), or other similar regional natural resource management body, is established in each catchment level based on the legal

basis of each state and is responsible for integrated catchment management. For example, in Victoria, there are 10 CMAs based on the Catchment and Land Protection Act 1994 (see 9.2.4).

According to the Victorian Government website, ICM is explained as follows:

The key goal of land and water management in Victoria is sustainable development, which requires the complex integration of ecological, economic and social objectives. The Victorian Government is committed to integrated catchment management as an important way of achieving sustainability. In Victoria, the concept of integrated catchment management (ICM) underpins sustainable management of land and water resources and contributes to biodiversity management. Victoria's whole of catchment approach to natural resource management seeks to deliver environmental, social and economic outcomes for the community and reduce our ecological footprint (source: <http://www.dse.vic.gov.au/land-management/catchments/catchment-management-authorities>, accessed 17 October 2012).

As an example of a concrete program, the following plan document was published by the Government of Victoria in 2000:

- Victoria's Salinity Management Framework: Restoring our Catchment (DNRE, 2000).

Each CMA has to create a Catchment Plan (CP). These plans have various names: Integrated Catchment Management Plan, Action Plan, Environmental Implementation Plan, Watering Plan, Regional Catchment Strategy, etc. Moreover, in NSW, it is called the Catchment Action Plan.

In the Regional Catchment Strategy (RCS) in the North Central (one catchment area in Victoria), the following statements are an example of the CP program.

The natural resources provide immense value to the whole community in a range of ways, for example, agriculture, recreation, tourism and lifestyle. To continue to provide these and other benefits, the natural resources must be managed sustainably to maintain or enhance their condition. Everyone in the region has a role to play ... The RCS is underpinned by the following principles:

- a) Protect and improve the region's natural assets for multiple local and downstream benefits.
- b) Strengthen region-wide community ownership and participation in decisions related to on-ground activity.

- c) Recognise and promote the value of biodiversity in sustaining productive landscapes.

The region requires effective partnerships at all levels to ensure ownership of natural resource management programs. Finally, there must be a commitment to build the community's capacity to take advantage of environmental, social and economic opportunities (NCCMA, 2003, p.3).

Next, at a sub-catchment level, the CMA is responsible for establishing more concrete and more site-specific programs in cooperation with non-government organisations, such as Landcare, and local self-governing bodies.

When CPs are compared with conventional natural-resources management, some overlap is evident, but they differ greatly in that in the management of conventional natural resources, an expert manager makes decisions on the most efficient civil engineering means for the given subject, independent of residents' opinions. (For example, whether a dam is built or not, what kind of type and on what scale). According to an ESD principle, CP reflects upon material civilisation and economic growth, manages it in the form where the influence of human activities on natural resources is maintainable, and aims at adjustment for a many-sided interest, and improvement in more long-term profits.

Therefore, the following points serve as an important issue, and CP becomes a special feature:

- public presentation and sharing of information
- consensus and adjustment by stakeholders
- examination of different choices containing a ‘zero option’
- decision-making on resource utilisation with multiple-purpose and comprehensive consideration in the long run
- preservation of ecosystems
- capacity building of residents
- adaptive management.

The many-sided and comprehensive character of CP may be a weak point, but it is also a strong point. That is, many targets need a diversity of policy instruments and need a still bigger source of revenue. If stakeholders increase in number, generally regulatory cost will become high indeed. Moreover, whether citizens’ participation in municipal affairs can be accommodated to the level needed by CP will pose a problem.

However, the experiment mentioned above is not considered difficult and the present and integrative (i.e. environmental, economical and social) catchment area management is conducted in Australia. Refer to Chapter 11 for the details of the CMA’s activity.

1.2.7: The challenge of the MDBC/A

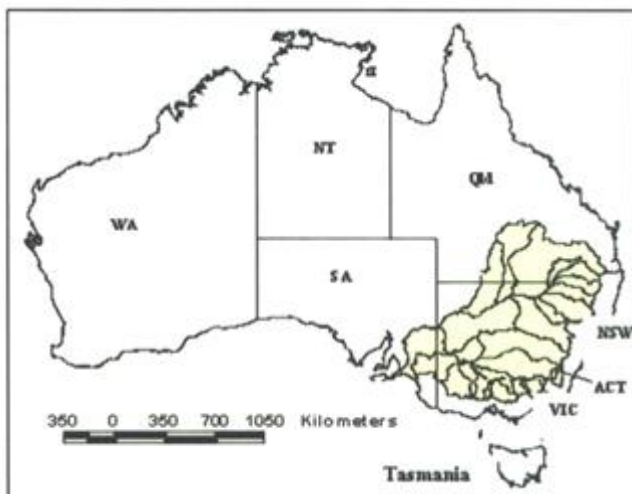


Figure 1.5: the position of the MDB

(Source: MacDonald and Young, 2000, p.8, partly modified)

The Murray-Darling Basin Commission (MDBC) was called the ‘world’s largest integrated catchment management program’ (Crabb, 2003, p.244). Moreover, the MDBC was a Trinity-type organisation of unique political, administrative and citizens’ participation in municipal affairs over the states that manage the Murray-Darling Basin (MDB). Explanation about this organisation and its activity is given below. However, the MDBC was replaced by the MDBA (Murray-Darling Basin Authority) in 2008, and administrative power was also strengthened but both characters as an inter-governmental

agency and trinity-type organisation were lost. Chapter 9 discusses the activity and basin plan of the new MDBA.

The specific importance of the MDB to the whole Australian economy is as follows.

It occupies 14 per cent of the land area and straddles four states and one territory. (It occupies 75 per cent of NSW, 15 per cent of Qld, 56 per cent of VIC, 8 per cent of SA and 100 per cent of ACT [MacDonald and Young, 2000, pp.8-9]) and, according to the DVD *More Than A River*, created by the MDBC, it occupies 72 per cent of the irrigation agricultural value of production of Australia, 43 per cent of farmhouses, 50 per cent of grain, 50 per cent of sheep, 25 per cent of livestock, 34 per cent of dairies, 34 per cent of wheat, and the annual tourist income is AUD\$3,400 million. The southern part of the MDB has a relatively stable river-flow rate compared to the northern part due to dam construction (it conducts 90 per cent of the Snowy River to the Murray River), and made the development of Australian irrigation agriculture possible. In addition, it is the most important area of agriculture as a 'food bowl' of Australia.

The MDBC, which coordinated the management of the basin until 2007, was established in 1988. The Murray-Darling Basin Agreement was concluded in the previous year. In the past the MDBC was called River Murray Commission (RMC). The

RMC was founded in 1917, based on the River Murray Waters Agreement (RMWA) in 1915, and managed the River Murray for about 70 years. The main activities of the RMC were stabilising the flow of the River Murray for responding to the increased water demand accompanying irrigation agriculture and urbanisation, and dam construction (the Hume dam completed in 1936, the Dartmouth dam completed in 1979, etc), and management of those were the main role of RMC. The reservation of water activity took priority in the RMC and the concern about environment or resource preservation and water quality was low. However, the state of the economy or environment began to change and people's values also changed. As a result, reform of the RMC arose as a reaction to deterioration in the environmental state of the Murray-Darling Basin (Crabb, 2003, p.241).

The federal government, NSW, Victoria and SA participated in the first agreement made in 1987 (MDB Agreement of 1987). Although there was revision of the RMWA, this agreement became insufficient and the old agreement was revised completely in 1992 and a new one created. Queensland also formally participated in the new agreement in 1992 and the ACT participated as an observer. The MDB Agreement of 1992 freed itself from the state level, became the Murray-Darling Basin Act in 1993, obtained the recognition of the Australian government,

and acquired legal standing (Crabb, 2003, p.242). Since direct management of the Murray River is one section of MDBC, it is now performed by the River Murray Water (RMW).

The purpose of the MDB Agreement of 1992 was ‘to promote and adjust the fair and effective plan and management of water, land and other environmental resources of Murray-Darling Basin for sustainable use’ (Crabb, 2003, p.242). In order to achieve this, a new institutional device was created consisting of the following three organisations:

- (1) MDBMC (Murray–Darling Basin Ministerial Council)
- (2) MDBC (Murray–Darling Basin Commission)
- (3) CAC (Community Advisory Committee).

The MDBC and CAC reflected the opinion of the administrative and community levels respectively and the MDBC took charge of ongoing office work and management. The MDBMC was the top decision-making body of the MDB and the MDBC was given a role supportive of decision-making. The MDBMC consisted of cabinet members (three persons at the maximum) from each state, with responsibility for land, water and environmental resources management, and a participant (one person) from the ACT without the right to vote. The federal

government's agricultural minister traditionally was the chairperson.

The CAC had an independent chairperson and consisted of twenty-one representatives elected according to the catchments, four representatives of organisations with special relationships, and one representative for the Aboriginal community. The main duty of the CAC was giving advice about management of natural resources and conveying the problems of the community in the basin. The CAC accepted the relationship with the Ministerial Council and the commission. That is, the basin residents' interests were fully positioned in the systematic and institutional structure.

The duty of the MDBC is to assist the Ministerial Council. The main duties of the MDBC are managing the River Murray (this duty specifically serves as work of one section inside the MDBC called River Murray Water), promoting integrated catchment management strategy including the anti-salinity program, creation and management of watering plan, etc. The commission office was a permanent organisation with support responsibilities. Furthermore, the MDBC was in charge of planning the concrete and special policy, establishing various working groups and committees and cooperating also with various government organisations or the CAC. Eventually these

organisations were generalised under two commissioners (Crabb, 2003, p.244).

To illustrate the historical meaning of the MDB Agreement in 1987 and its establishment of the MDBC, Quiggin used Randall's (1981) diagram showing conversion from the expansion phase to maturity phase of water resources policy, and applied the following contrastive explanation (Quiggin, 2001, p.75):

- Expansion phase: the aggregate total cost and marginal cost accompanying extension of water resources are low. Water supply is flexible. There is almost no externality. The construction and maintenance cost of infrastructure is low. (The cost–benefit ratio of infrastructure is high).
- Maturity phase: the aggregate total cost and marginal cost accompanying extension of water resources are high. Water supply is inelastic. Various environmental problems (the rise of the groundwater level, damage from salt water, declining water quality, etc) are generated. The construction and maintenance cost of infrastructure is high. (The cost–benefit ratio of infrastructure is low).

The establishment of the MDBC involved a change of the social setting surrounding the water resources policy (i.e. the

conversion to the maturity phase from the expansion phase), and was carried out ‘expressing officially that the establishment of a new mechanism (i.e. the MDBC) cannot maintain the conventional water resources management’ (Quiggin, 2001, p.75).

The three organisations (MDBMC, MDBC and CAC) raised one new strategy after another, as a whole called the Murray-Darling Initiative.

- CAP: in 1995, the MDBMC introduced a measure (moratorium) postponing further diversions from the basin, and this measure was perpetuated as a CAP after that on 1 July 1997. The purpose of the CAP was to suppress the maximum quantity of water intake at the 1993/94 level, and each state had to decide on a water resources management plan and achieve the increase in efficiency needed to introduce this system. Expansion and enhancement of the water market were urged by the introduction of CAP and it also had a big influence on COAG’s water reforms. Thus, the introduction of CAP symbolised the conversion of the Murray-Darling Basin from the expansion phase to the maturity phase. The quantity of water intake from the MDB had reached about 85 per cent of the average natural flow to the sea at that

time, as shown in Figure 1.6. If the increase in diversions continued until 2020 if there was also no political control, it was predicted that this figure would exceed 90 per cent. Superfluous use (over-allocation) of the river water by people has already approached the limit at MDB.

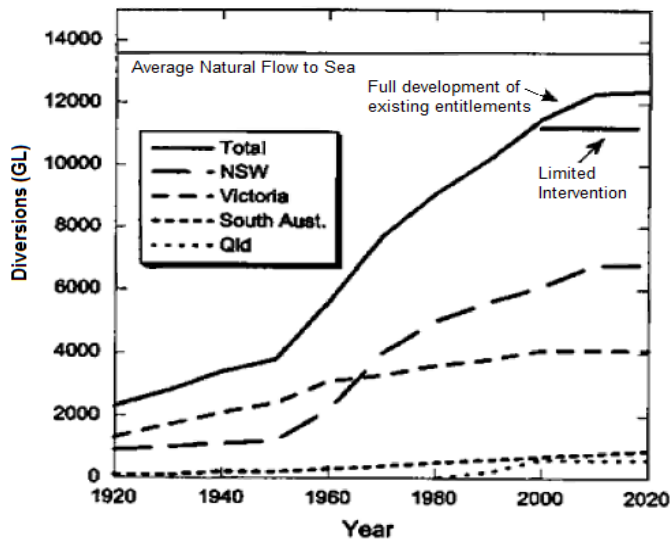


Figure 1.6: transition of the annual diversions from the Murray-Darling Basin
 (Source: Quiggin, 2001, p.74 and originally from MDBC 2000a, partly modified)

- Integrated Catchment Management in the Murray-Darling Basin 2001-2010: Delivering a Sustainable Future: This plan, announced officially in 2000, accepts the common property side of the MDB and clarifies the importance of the integrated catchment management for preserving it. It is referred to as 'the plan which the community and the

government organisation created for the natural resource management of a future MDB' (Crabb, 2003, p.244. Refer to 1.2.6 for ICM).

- Basin Salinity Management Strategy 2001–2005: For details, refer to Chapter 10.
- The Living Murray Initiative (First Step): This enterprise covers five states. A discussion paper was released in 2002. It was called the greatest independent environmental regeneration enterprise in Australia. The centre of this enterprise was securing an environmental flow and returning the water to the environment. The Murray-Darling Basin Water Agreement was signed at the 25 June 2004 meeting of COAG, and it agreed on AUD\$500 million being invested in the area in the five years from 2004/05. Later, an additional AUD\$500 million was added. For details, refer to Chapter 11.

In addition to the above the MDBC tackled management of land use, environmental flow, measures against damage from salt water (especially Salinity Credits Register) and correspondence on climate change risk, citizens' participation in municipal affairs, education, etc. Salinity is an especially serious problem regarded as a life or death issue for the MDB over hundreds of years from now as there is the possibility that about 20 per cent

of the land in the basin may become unsuitable for agricultural irrigation by 2050 (Smith, 2003, p.57).

A salinity audit performed by the MDBC in 1999 issued the following warning:

‘The average salinity of the lower River Murray (monitored at Morgan) will exceed the 800 EC threshold for desirable drinking water quality in the next 50-100 years. By 2020 the probability of exceeding 800 EC will be about 50 per cent.’ (MDBC, Salinity Audit, 1999a, p.vi).

Chapter 10 discusses in detail the measures taken against damage from salinity, including the Basin Salinity Management Strategy 2001–2005.

Let us summarise Section 2.

It is necessary to regard water market reform in Australia as part of overall water reform, which has the following three subsystems connected sustainable development and the national competition policy:

- (1) Reform of water rights
- (2) Reform of water industry (i.e. corporatisation) including the foundation of water market
- (3) Development of integrated catchment management.

While these overlap by making the introduction and development of a water market into a core issue, water reform is pursued as a whole. These subsystems and the relation of a water market are discussed in detail in Part II.

Section 3: Water resources of Australia and the MDB

1.3.1: Features of Australia's water resources

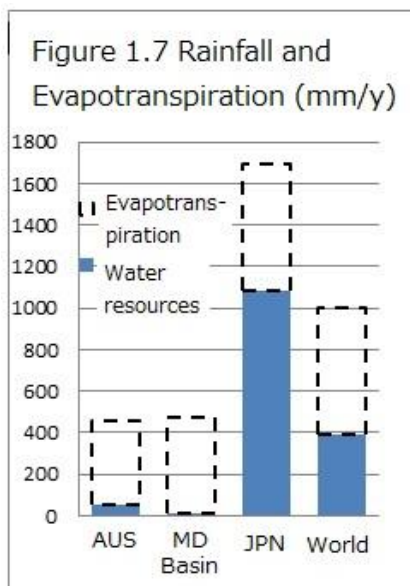
The water resources of Australia and the MDB are very specific. First, even looking at the precipitation of Australia from a global average, there is very little. This is the reason it is called the world's driest continent (except Antarctica) (Smith 1998, p.4). And since the evapotranspiration loss is very large, it may be able to use about 10 per cent of precipitation. (We will call this ratio the water resources potential use rate: WRPUR). Japan's WRPUR is 64 per cent and the global average is 39 per cent. But in the MDB it is only 1.7 per cent. Moreover, the spatial/time deviation of the water resources of Australia is large and the WRPURs of states are spatially distributed from 2.8 per cent even to 44.3 per cent variously (refer to Table 1.2). If the ratio (B/C of Table 1.2) of the amount of water resources to total land area of each state and the farm land ratio are compared, and comparatively small-scale areas, such as Tasmania and ACT and the low farm land ratio, such as Tasmania, the ACT, WA and NT, are removed, the areas potentially considered to be suitable

for irrigation agriculture are Victoria, Queensland and NSW. Furthermore, if an arid region (average annual open-water evapotranspiration is an area of 2000 mm or more) is removed from here, the proposed site of the irrigation agriculture of Australia will be obtained. It overlaps with the valley where the three big rivers emit from the Great Dividing Range (mainly Australian Alps), i.e. the Murray River, the Murrumbidgee River and the Goulburn-Broken River. This is exactly the southern part of the MDB.

	Australia	MDB	Japan
Area (km ²)	7,617,930	1,042,730	377,944
Population (million)	22.62	2.1	127.8
Density (person/km ²)	2.8	2.0	337.1
GDP (USD)	\$1.372 trillion (2011)	\$14.991 billion AUD*	\$5.867 trillion (2011)
Precipitation (mm/y)	534 (2009) 455(LTA**)	469 (1990– 2006)	1688 (2009) 1693 (1976– 2005)
Evapotranspiration (mm/y)	399(LTA)	461 (1990– 2006)	609 (1976– 2005)

Table 1.1: fundamental parameters about Australia and MDB

Note: *Gross value of agricultural production , **LTA=long-term average
(Source: MDBA, 2010, p.14, web page of World Bank, Smith, 1998, pp.3-5)



(Source: created from Smith, 1998, pp.3-5)

	Rainfall l (mm)	Rainfall l (GL):A	Run- off (GL)	Ground water recharge (GL)	Total water resources: B	B/A	Total land area('0 00 ha):C	B/C*10 0	*Farm land ratio (%)
ACT	748	1767	149	29	178	10.1%	236	75.4	24.6
NSW	506	406562	30266	7133	37399	9.2%	80064	46.7	72.8
NT	376	505623	47151	8382	55533	11.0%	134913	41.2	41.3
QLD	502	865973	93018	13599	106617	12.3%	173065	61.6	80.8
SA	151	147773	1285	2925	4210	2.8%	98348	4.3	53.7
TAS	1121	75189	32084	1228	33312	44.3%	6840	487.0	24.2
VIC	648	146928	14266	2695	16961	11.5%	22742	74.6	55.5
WA	254	639609	24560	13182	37742	5.9%	252988	14.9	35.1
AUS	364	278942 4	242779	49174	291953	10.5%	769202	38.0	53.3

Table 1.2: water resources in Australia, 2004–05

(Source: created from web pages of NWC, ABS 2012, Australian Government, accessed 17 October 2012. *Farm land ratio=area of farms/total land area [per cent])

1.3.2: Features of the MDB's water resources

The distribution of the MDB's water resources is not equal. Nearly two thirds of the average annual consumptive surface water use across the MDB occurs in the Murray, Murrumbidgee and Goulburn-Broken regions (CSIRO, 2008, p.6). And the MDB is an area that, as a whole, has little rain and where evaporation loss is also larger than the average precipitation of Australia, as shown in Table 1.1.

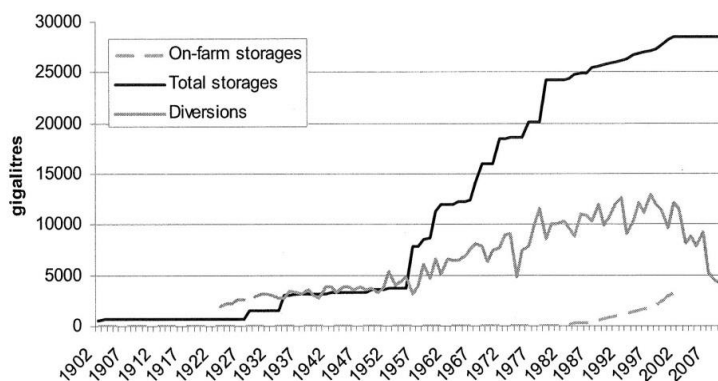
The CSIRO report described the water balance of MDB as follows:

‘The majority of the MDB water balance is negative – that is, evapotranspiration exceeds rainfall. On an annual basis, the balance is positive only in limited areas mainly in the south-east of the MDB. In winter when evapotranspiration is low and rainfall in the south is higher, the balance is positive over much of the MDB. The balance is positive in the northern regions in the summer due to the summer dominance of rainfall in these areas ... Annual streamflow is most variable in the north of the MDB and is least variable in the south-east corner of the MDB.’ (CSIRO, 2008, p.15)

Therefore, in order to actualise the possibility of irrigation agriculture in the MDB, construction of large-scale irrigation

institutions or storage facilities were inescapable. A report by the Productivity Commission (PC) report explains:

‘Water storage and delivery infrastructure help to manage rainfall variability and to create a more reliable supply of water. Australia has the highest water storage capacity per capita in the world. In 2001, Australia had approximately 500 large dams with a total storage capacity of 93,657gl’ (PC, 2010, p.263).



(Note) Total storages excluding barrages, weirs and the Snowy Catchment.

Figure 1.8: growth in storage and diversions over time in the MDB
(Source: PC, 2010, p.23, originally from MDBA, 2009, partly modified).

From the end of the 1950s to the beginning of the 1980s, Australia strived for construction of large-size and/or deep dams in order to achieve big increases in water availability and economies of scale and/or to prevent loss by transpiration (see Fig. 1.8).

The current average surface water availability across the MDB is shown in Figure 1.9. This clearly illustrates the dominance of the south-eastern portion of the MDB in terms of water availability. The importance to irrigation agriculture of the Murray River (14,493GL, assessed at Wentworth), the Murrumbidgee River (4270GL, assessed at Darlington Point) and the Goulburn River (3233GL, assessed at the river mouth) can be seen clearly.



Figure 1.9: current average surface water availability across the MD
(Source: CSIRO, 2008, p.29, partly modified).

Note: more than 60 per cent of the total surface water resources of the MDB is in the Murray, Murrumbidgee, Ovens and Goulburn-Broken regions)

System	Surface Water Use	Groundwater Use	Total Water Use
NSW	6,265	935	7,200
VIC	3,975	119	4,094
SA	720	30	750
QLD	584	148	731
ACT	33	1	34
Total MDB	11,576	1,233	12,809

Table 1.3: average annual water use in the MDB (GL/y)

(Source: MDBC, 2003b, Fact Sheet.

Note: consumptive use only)

The water-use situation for the MDB is as follows. Inflows which come into the MDB through various rivers as run-off are on average 32,800gl. In this figure, under what was originally called the Snowy Mountains Scheme, 1000gl of water was diverted into the MDB and water that would normally flow into another valley was also contained (MDBA, 2010, p.15).

Moreover, according to the CSIRO, the flow of the river (run-off) in the main areas across eighteen regions of the MDB is 23,417gl/year on average (CSIRO, 2008, p.9). Almost half that flow is lost to natural processes (Pigram, 2006, p.160). And although the water actually used (diversions) for agricultural irrigation at the MDB was around 11,000 GL/year by the

introduction of CAP in 1995, and the drought from 1997 to 2009, the amount of the water used from the MDB decreased from the end of the 1990s and became about 8000gl/year as of 2005 (refer to CSIRO, 2008, p.17 and Figure 1.8). In addition, in the MDBC's fact sheet for 2003, the average MDB surface water used was 11,576gl/year and total amount of used water serves as 12,809gl/year together with groundwater (refer to Table 1.3).

From the above considerations, the outline of the MDB's water use is summarised in general in Figure 1.10. The stream flow at the mouth of the Murray River is estimated at 12,233gl/year. When 12,233gl is considered to be the maximum amount of water that people can use on average, it is said that the present availability of water to people is 92 per cent ($=11,327/12,233$). This clearly shows a superfluous exploitation of water resources of the Murray.

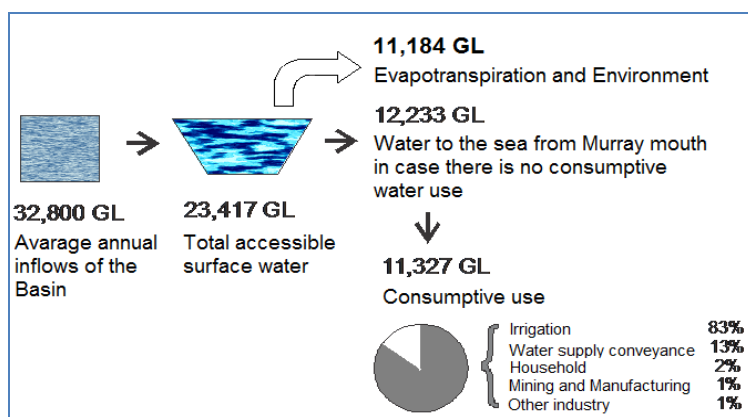


Figure 1.10: average water use in the MDB

(Source: created from MDBA, 2010, p.15 and CSIRO, 2008, p.28).

Section 4: Outline of irrigation agriculture in the MDB

According to the CSIRO and the Basin Plan, the state of irrigation agriculture in the MDB is as follows:

- Agriculture is the dominant economic activity in the MDB, covering nearly 80 per cent of the basin and generating more than 40 per cent of the gross value of Australian agricultural production. The MDB uses 60 per cent of all irrigation water in the country and is often referred to as Australia's 'food basket' (CSIRO, 2008, p.14).
- In the present land use of the MDB, 20 per cent of land use is natural vegetation, and 79 per cent is agriculture. Irrigation agriculture is 1.8 per cent of total land use. (refer to Table 1.4)

Land use	Area (% , ha)	
Dryland crops	10.5%	11,001,881
Dryland pasture	66.7%	69,970,726
Irrigated crops	1.8%	1,916,256
Cereals	(0.4%)	467,178
Cotton	(0.4%)	426,519
Horticulture	(0.0%)	46,622
Orchards	(0.1%)	67,912
Pasture and hay	(0.8%)	820,890
Vine fruits	(0.1%)	87,135

Native vegetation	20.3%	21,242,551
Plantation forests	0.4%	445,048
Urban	0.3%	276,104
Total	100.0%	104,852,550
Water	—	943,861

Table 1.4: MDB land use, 2000

(Source: CSIRO, 2008, p.14).

- In dollar terms, the most significant commodities produced in the basin during 2005-06 were grain (A\$3.4 billion), beef cattle (A\$2.8 billion) and sheep and other livestock (A\$1.7 billion). However, the recent prolonged drought (1997-2009) significantly curtailed both cotton and rice production. The basin was responsible for 45 per cent (A\$5.5 billion) of Australia's total 2005-06 irrigated production (A\$12.2 billion). The basin is home to a number of significant irrigated agricultural areas. For example, most of Australia's rice is produced in the Murrumbidgee and NSW Murray irrigation regions and 90 per cent of the nation's cotton comes from the northern basin. The basin also provides 56 per cent of Australia's total grape crop, 42 per cent of Australia's total fruit and nut production and 32 per cent of Australia's total dairy

production. A variety of crops and pasture are grown in the basin for food, fibre and, more recently, bio-fuel for domestic consumption and export. These include:

- cereals (e.g. wheat, barley, rice, sorghum)
- cotton
- legumes (e.g. field peas)
- fruit and nuts (e.g. apples, oranges, almond)
- grapes
- vegetables (e.g. tomatoes, onions)
- canola
- livestock fodder (e.g. pasture for grazing or hay/silage). (MDBA, 2010, p.21)

The main irrigated districts of the MDB are as follows, according to the PC report (refer to Table 1.5.).

Irrigation district	Area (ha)	Entitlement (ML)	Location	Major irrigated crops	Irrigated industries
Coleambally	95,153	497,892	West of Wagga Wagga, central NSW	Wheat and rice	
Murray Irrigation	748,000	1,479,000	Southern NSW	Rice and annual pastures	Rice and cereals
Murrumbidgee	480,000	1,193,370	Near Griffith, NSW	Rice and horticulture	Rice and wine

South-east region	80,000	718,685	South-east SA	Pasture and grapes	Beef and wine
Central Irrigation	15,000	155,751	North-east of Adelaide, SA	Grapes and citrus	Wine and juice
Murray Valley	122,457	273,657	Central-north, VIC	Perennial and annual pasture	Dairy and can fruit
Torrumbarry	173,366	352,109	Central-north, VIC	Perennial and annual pasture	Dairy and grazing
Central Goulburn	172,131	455,660	Central-north, VIC	Perennial and annual pasture	Dairy and horticulture

Table 1.5: major irrigation districts in the MDB

(Source: PC, 2006, p,267)

According to Pigram, the location of main irrigated land in the MDB is as follows (refer to Figure 1.11).

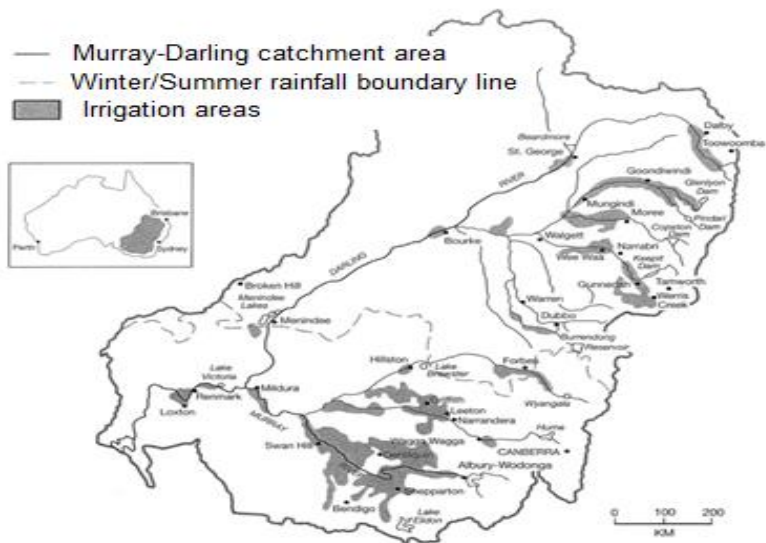


Figure 1.11: areas under irrigation in the MDB
(Source: Pigram, 2006, p.130, partly modified)

The agricultural output by sector and region in 2006 is cited in Figure 1.12.

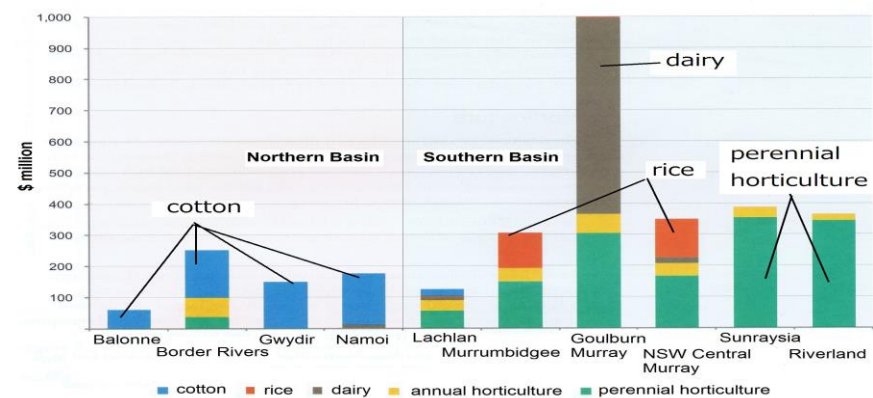


Figure 1.12: irrigated agricultural production
by sector and region, 2006
(Source: MDBA, 2010, p.85, partly modified).

Section 5: The present condition of Australia's water market

Let us check the reaching point of the latest water market.

	2007– 08	2008– 09	2009– 10	2010– 11
Number of trades	4,286*	32,051	29,501	15,333
Entitlement trade volume (GL)	920	1,800	1,949	1,204
Allocation trade volume(GL)	1,594	2,158	2,495	3,493
Total number of volume (GL)	2,514	3,958	4,444	4,697
Interstate water allocation trade (GL)	223	688	497	866
Estimated entitlement trade turnover (A\$ million)	845	2,215	2,595	1,341
Estimated allocation trade turnover(A\$ million)	836	606	366	129
Total turnover(A\$ million)	1,681	2,821	2,962	1,470

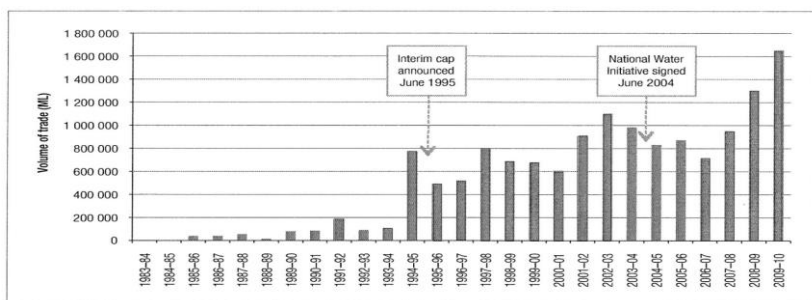
Table 1.6: results of recent water trading

(Source: NWI Report, 2007–08, 2008–09, 2009–10, 2010–11.

Note: above figures include areas other than MDB.

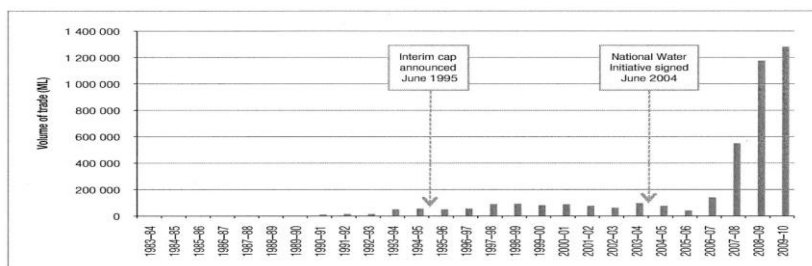
***Not included allocation trade)**

Although there are two separate water markets, a permanent market (entitlement trade) and a temporary market (allocation trade), if looking at the number of deals amounts to 20,000 in total, If looking at the dealings in amount of water, it amounts to 4500gl , and if looking at the amount of money traded, it amounts to more than A\$2 billion.



**Figure 1.13: volume of allocation trade, southern
MDB, 1983-84 to 2009-10 (ml)**

(Source: NWC, 2011f, p.63, partly modified)



**Figure 1.14: entitlement trade volume in the southern
MDB, 1983-84 to 2009-10 (ml)**

(Source: NWC, 2011f, p.64, partly modified)

The allocation trades increase rapidly from 1994-2005, and though accompanied after that by comparatively big fluctuations, it has the tendency to increase. Although the entitlement trades were small-scale at first, they increased rapidly from 2007-08 and onwards. It now equals one third of the temporary market in the amount of water (see Table 1.6)

States and Territories	Surface water		Total (GL)
	Groundwater (GL)	(GL)	
NSW	9,940	1154	1,1094
QLD	4,705	899	5,604
VIC	4,729	870	5,701
WA	946	1,491	2,437
SA	844	530	1,374
TAS	1,650	0	1,650
NT	132	126	258
ACT	75	1	76
Total	23,011	5,071	28,184

Table 1.7: entitlements on issue at 30 June 2010

(Source: NWC, 2010b, p.14, p.101)

The water rights issue situation is shown in Table 1.7.

Compared with the actual amount of water used, it is clear that water rights are issued superfluously about twice as much (i.e.

the amount of water rights / use amount of water = 23011/10940.
MDBA, 2010, p.44).

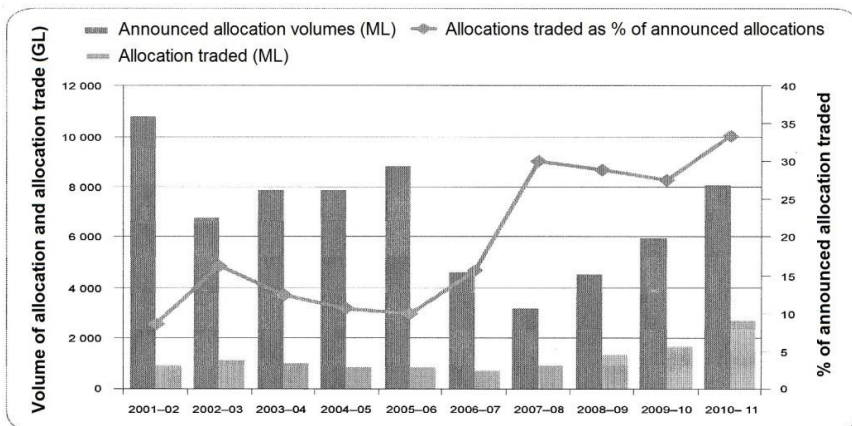
The following tables investigate the type of water market irrigation in which farmers have participated. According to Table 1.8, about 50 per cent of irrigation farmers will use a temporary market and about 5 per cent participated in the permanent market.

	Dairying	Broadacre	Horticulture	All irrigation farms
Year	*A * B * C	*A * B * C	*A * B * C	*A * B * C
Permanent entitlements	7 12 10	2 6 6	2 4 2	3 6 5
Temporary irrigation water	45 47 54	30 41 43	33 57 52	34 51 50

Table 1.8: percentage of Murray-Darling Basin irrigation farms trading water, by agricultural sector, 2006-07 to 2008-09

(Source: NWC, 2011f, p.70. *A=2006-07, *B=2007-08, *C=2008-09)

Furthermore, the NWC's report (Figure 1.15.) shows that the water purchased through the water market forms about 35 per cent of distributed water now, and that the ratio is being further stabilised in spite of a change in distributed water.



**Figure 1.15: water allocation levels and proportions traded,
southern MDB, 2001-02 to 2010-11**
(Source: NWC, 2011b, p.23. partly modified).

The water market is also useful for the re-allocation of water resources between states. Table 1.9 looks at the ratio of intrastate and interstate trade to allocation trading in each state. This shows interstate trade has played a large role and occupies around 30 per cent of allocation trading.

	NSW	Vic	SA	Total
	Internal Interstate	Internal Interstate	Internal Interstate	Internal Interstate
2010– 11	83% 17%	77% 23%	35% 65%	73% 27%
2009– 10	75% 25%	81% 19%	81% 19%	77% 23%
2008–	58%	94%	96%	67%

09	42%	6%	4%	33%
2007–	74%	87%	99%	83%
08	26%	13%	1%	17%

Table 1.9: intrastate versus interstate allocation trading as a proportion of state trading, southern MDB, 2007-08 to 2010-11 (per cent).

(Source: NWC, 2011b, p.22)

In addition, the water market has also played an important role in respect of purchasing water for the environment and for cities. For example, the water purchased by the federal government for the environment in the 2010-11 fiscal year was 255gl, forming 24 per cent of the water entitlements trading in the MDB that year (NWC, 2011d, p.6).

Aspect of the water supply to the cities include:

- There was a large increase in the participation of urban water authorities in the water market during the drought. For example, SA Water was a significant purchaser of water allocations to boost supply security in Adelaide. In Victoria, Coliban Water and Central Highlands Water bought a mix of entitlements and allocations to address critical supply shortfalls in Bendigo and Ballarat. There has also been an increase in connectivity between urban centres and rural water markets, including major investments to link Melbourne and Canberra to the water

market in the southern MDB. (NWC, 2011a, Short History, p.81)

- Consultations undertaken for this study confirmed that shire councils were using the market to ensure that sufficient water was available to maintain parks, gardens and sporting grounds, as well as lakes and environmental areas. As the drought has persisted, rural-urban trading has been recognised as essential to sustain the aesthetic appeal of communities for the mental health of residents and to attract new residents and tourists (NWC, 2010a, Impacts, p.73).

Moreover, the water market has also produced new job descriptions, such as brokers who carry the internet market and water trading (see Table 1.10).

Exchange	Ownership	Regions serviced	Method of operation
Watermove*	Victorian Government	Vic. and southern NSW	Weekly pool (operated by G-MW)
Waterexchange	The Envex Group	Vic., NSW and SA	Posted sell and buy
Murrumbidgee Water Exchange	High-security irrigators	NSW	Posted sell and buy
Murray Irrigation Water Exchange	Murray Irrigation Ltd	NSW	Posted sell and buy
Waterfind	Privately owned	Vic., NSW, SA and Qld	Posted sell and buy
Watermart	CICL **(acting as a Broker for Waterexchange)	A service for CICL customers	Posted sell and buy

Table 1.10 Principal water exchanges and methods of operation

(Source: NWC, 2011c, p.23 and PC, 2010, p.49, partly modified.

Notes: *Watermove closed in August 2012. But a group of farmers are behind a new cooperative-based water exchange company that intends to take over the role of the former Watermove in setting public pool prices, website <http://www.mmng.com.au.local-news/country-news/new-water-pool-set-up-by-farmers-1.31114>. accessed 19 October 2012. **CICL = Coleambally Irrigation Corporation Limited)

Thus, the Australian water market of today is not only performed by the specific participants within specific irrigated areas but it is actively performed across states, and also spreads out to areas other than the MDB, such as Tasmania and WA, although at present these markets are very small. Moreover, dealings have not only targeted surface water (regulated surface water), but also the water resources (unregulated surface water) of the river which are not regulated, and groundwater. The water market is now indispensable to Australia's irrigation agriculture. Furthermore, in new fields, such as the conservation of water for the environment and for cities, the water market is playing an important role in water resources re-distribution. It can be said that the water market of Australia has reached a new level, unique in the world in scale and function.

Many useful lessons, not only for Japan but for the world, can be drawn from the experience of Australia.

Finally, we would like to describe the time classification of the water market up to now. We divided the old water market development at four terms, and understand it as follows:

- **The first term:** preparation (1982–1988). Temporary dealings of water started lawfully in SA 1982. Temporary dealings started also in NSW or Victoria after that. However, water dealings were limited to public irrigation districts or private diverters. Concern about environmental problems increased and a desire for new alternatives replaced the conventional water resources management.
- **The second term:** establishment (1989–1994). Cooperation between politicians and environmentalists increased with the rise of concern about environmental problems. The MDBC was established in 1988. Meanwhile, water rights were legally separated from land, and water rights trading was truly enacted in 1989. Permanent trading started in 1991 in Victoria. The water trading restricted to the farmers in the same irrigation area was extended to the trade between different irrigation areas, between river diverters and irrigation districts, and between river systems. Moreover, corporatisation (public sector reform) of water organisation came into being and positioned as part of wider water reform for the creation of a water market to solve the problem of sustainability.

- **The third term:** expansion growth (1995-2006). In 1994 reform by COAG started, creating expansion of the water market across the MDB. This led to the introduction of CAP and the huge expansion and interstate trade of the water market (especially a temporary market). Temporary trading was substantially accelerated by the worst drought on record (from 1997/98 to 2010/11, with 2006 representing the driest year on record for much of southern Australia) that produced substantial water shortages and hence a stronger need to trade to adjust farm businesses under drought conditions.
- **The fourth term:** maturity and new deployment (2007 to present). With the rise of new concerns about environmental problems, the importance of the market technique has been recognised with The Living Murray Initiative (TLM), and government of water for the environment got into its stride in 2007. Whether because of the influence of drought or because of the purchase of water for the environment, water rights dealings (permanent trading) began to increase and qualitative and structural change took place in the water market. In the state of Victoria, unbundling started and a new foundation for the development of the water market was set. Similarly, there was the formation of the Water Act and the MDBA at the federal level. Moreover, much more refinement of

the water market was added by the National Water Initiative (NWI).

Chapter 2

Social Systems as a Vehicle to the Future

Section 1: Introduction

What kind of society is desirable?

Although it is an age-old problem, it has become even more complicated in present times, with such a diversity of values informing people's happiness. Furthermore, there is hesitation in interrogating the problem of social systems, now that 'socialism' has collapsed as an ideal, exposing various inefficiencies.

However, when we think about a future society, for example, a 'sustainable' one, we see that this is an important problem that cannot be overlooked.

We think that this problem should be divided into two stages that should be considered separately. Specifically, we should sharply distinguish the domain of material production from the domain of wealth distribution (or social surplus) for the time being. The latter problem is much more complicated, including metaphysical debates involving value judgements and religious principles, but we can argue comparatively briefly about the former problem.

Looking at society from the perspective of material production involves thinking in terms of fixed technical capabilities and resources (for example, land) and the labour

force. Workers are considered as 'P' and resources are 'R'. Workers use the fixed resources, 'R', and the products, 'x', of this society shall be produced by supplying the labour, 'N'. Labour productivity (= products / injection labour quantity) is defined as 'l' ($=x/N$). When labour productivity changes with workers, it is written as ' l_i ' ($=x_i/N_i$) etc. ($i=1, 2, \dots, P$). The resources needed for the fixed quantity of production is written as 'a' similarly (a : Resource input coefficient $=R/x$). Therefore resource productivity can be written as $(1/a)$. In cases where resource productivity changes with workers, it is written as $(1/a_i)$. Moreover, labour input and the amount of labour supplies will be distinguished, and each labour input in a fixed period is written as ' N_i '. The latter is the same for every worker and is written as 'L'. (The maximum labour quantity which society can supply serves as $L \cdot P$.)

In addition, as this chapter argues, all societies assume that they are at a stage of technology in which surplus production is possible. That is, it is assumed that there are more products, 'x', created by every worker using resources than the quantity required by the workers and their families.

Section 2: Comparison of various social systems

2.2.1 Perfect equal resource allocation society

We will look at the society that distributes resources equally first. (We will call this ‘perfect equal resource allocation society’.) In order to simplify the argument, the resource input coefficient is the same for every worker, and is taken as ‘ a ’ again. Then, the per capita amount of resource allocation serves as R/P . Everybody performs production using these equal resources and one’s labour. If each quantity of production ‘ x_i ’ is seen from the side of labour, it is producible to $l_i \cdot L$, but from another side of the resource constraint, they also have to fulfill the conditions of $a \cdot x_i \leq R/P$. Therefore, each quantity of production in this society is either $R/(a \cdot P)$ or $l_i \cdot L$ for the smaller one. If it assumes that labour fully exists, each quantity of production will serve as $x_i = R/(a \cdot P)$ by a resource constraint, and all the members will perform an equal level of production. (The quantity of production for a society as a whole serves as R/a .)

However, although it is equal for each level of production, each injection of labour quantity ‘ N_i ’ serves as $N_i = x_i/l_i = R/(a \cdot P \cdot l_i)$, and differs. In other words, workers with high labour productivity can produce by few working hours, that is ‘ N_i ’, by attaining fixed quantity-of-production: $R/(a \cdot P)$, and the labour

productivity ' l_i ' is high as compared with others, so his free hours or leisure hours $=L-N_i$ will increase.

This 'perfect equal resource allocation society' has the remarkable feature of being eternally sustainable, if people protect a social norm strictly and resources are not drained. However, as we described, labour force is going unused in respect of resource utilisation in this society, because of the difference in labour productivity. (This society builds in the difference in time at leisure.) Since technical progress (rise of labour productivity or resource productivity) is considered a destabilising factor which creates deviation, such as in the allocation of working hours, in this society social progress and improvement in convenience also must be denied.

Moreover, when population increases, this society has to raise the productivity ($1/a$) of resources, or has to gain resources (R) from the others. This society has fixed external dependence (strong dependence on population or resources) rather than being autonomous. In other words, this society is vulnerable to external shocks like increasing population and technical progress.

Therefore, although a certain amount of consistency and durability is securable, it cannot but become a stagnant society governed by strong traditional social norms.

2.2.2 Perfect equal resource allocation society including technical progress

Next, although each resource allocation is the same as R/P and before, resource productivity increases, and we will analyse the case where it becomes unequal. Now, each unit of resource productivity can be expressed as $1/a_i$. (It is assumed that it is $1/a_i > 1/a$.) Since each quantity of production ' x_i ' becomes $x_i = R/(a_i \cdot P)$ (assuming that labour fully exists), in each quantity of production, a difference is clearly produced. Moreover, also individually, the society as a whole is increasing the quantity of production by the rise of resource productivity. However, since working hours ' N_i ' become $N_i = R/(a_i \cdot P \cdot l_i)$, they are dependent on the trend of $a_i \cdot l_i$. If the rise of resource productivity and the rise of labour productivity assume that it is the same grade, since $a_i \cdot l_i$ becomes constant, working hours are almost unchanged from the former society. (However, the point the unused labour has produced due to the difference in labour productivity does not change in this society from former society.) That is, this society is dynamic, expanding and growing through technical progress, and is capable of responding somewhat autonomously to changes in the social environment, such as an increase in population or exhaustion of resources. However, it still has built-in unused labour resources, and a traditional norm is strong.

This society could consider distributing many resources to a person with high resource productivity, although the distributions both of labour productivity (l_i) and resource productivity ($1/a_i$) remain unchanged. That is, the problem of whether it is possible to make the production of society increase without increasing in technical progress or resources is considered. If $a_i < a_j$, specifically, resource allocation which serves as $R_i > R_j$ will be considered.

In this case, each amount of resource allocation serves as ' R_i ', each quantity of production serves as R_i/a_i , and each labour input serves as $R_i/(a_i \cdot l_i)$. For simplicity, the i -th worker's resource productivity and the j -th worker's resource productivity are presented as $(1/a_i)$ and $(1/a_j)$, respectively, and it is assumed that it is $(1/a_i) > (1/a_j)$. The other person's resource productivity presupposes that it is the same.

In this setting, one unit of resources is added to the person with high resource productivity (i), and the distribution that subtracts one unit of resources from the person with low resource productivity (j) is considered. Then, although the change quantity of total output becomes $(1/a_i)$ minus $(1/a_j)$, since it is clearly, the total output for the society as a whole will tend toward an increase.

Thus, when each unit of resource productivity has a difference, a society's quantity of production can be made to

increase as a whole by decreasing the resource allocation to a person with low resource productivity, and re-distributing it to a person of resource productivity.

2.2.3 Capitalist system

Next, we will look at resource allocation in a society that is unequal from the beginning. For example, one capitalist has monopolised all the resources and the remaining persons (P) will have a society that holds only labour. Looked at strictly, the ‘capitalist’ here means the owner of capital. There is a distinction between an owner capitalist (no management of anything other than personnel, and only stock dividends are received based on the private ownership system) and a functional capitalist (management is commanded, and achievements are pursued and reshuffled depending on performance). The functional capitalist can also consider kinds of workers (for example, workers with management specialties). In this chapter, in order to understand clearly, a functional capitalist will consider kinds of workers.

First, when resources are equally distributed to P’s workers, resource allocation serves as $\{R/P, R/P, \dots, R/P\}$. Therefore, each quantity of production can be expressed as $\{x_i^1\} = \{R/(P \cdot a_1), R/(P \cdot a_2), \dots, R/(P \cdot a_P)\}$.

Next, suppose that resource allocation was changed according to workers' productivity. (We will not go into how this is done here.) New resource allocation can be written to be $\{R_1, R_2, \dots, R_P\}$, and $\sum R_i = R$ for the time being. Therefore, new each quantity of production can be written as $\{x_i^2\} = \{R_1/a_1, R_2/a_2, \dots, R_P/a_P\}$. A problem here is comparing the old production total amount $\sum x_i^1 = R/P \cdot \sum (1/a_i)$ with the new total amount $\sum x_i^2 = \sum R_i/a_i$.

If the difference between old and new total output is set to S , it will become

$$S = \sum R_i/a_i - R/P \cdot \sum (1/a_i) = \sum (1/a_i) \cdot (R_i - R/P) .$$

The way things stand, the sign of S is not determined. In order to work it out, it is necessary to decide how to re-distribute resources according to productivity. We will consider the following re-distribution method as an example.

$$R_i = R/P + \alpha \cdot (ar - a_i) , \quad ar = \sum a_i/P \text{ -----(1)}$$

Here, 'ar' is the average value of a resource coefficient. It is necessary to decide on a suitable positive numerical value so that a resource coefficient does not become negative, although α is a parameter given extrinsically. For example, if $R = 40$, $P = 4$, $(a_1, a_2, a_3, a_4) = (0.2, 0.4, 0.6, 0.8)$, four workers' equal resource allocation is set to $R/P = 10$. If this is re-distributed as $\alpha = 10$

according to (1) equation, it will be $ar=0.5$ and new resource allocation will be set to $\{13, 11, 9, 7\}$. In addition, in the case of this numerical example, the old quantity of production is set to $\{50, 25, 50/3, 50/4\}$, and the quantity from the new production is set to $\{65, 55/2, 15, 35/4\}$. Therefore, the old production totals = 104.17 and the production after the change totals = 116.25, so the level of production increased by 11.6%.

Now, if the (1) equation showing the rule of re-distribution is substituted and S is transformed, the following will be obtained.

$$S/\alpha = ar \cdot \Sigma(1/a_i) - P.$$

In order to show that the upper equation is positive or zero, it is necessary to show the following equation.

$$ar \cdot \{(1/a_1) + (1/a_2) + \dots + (1/a_n)\} \geq n, n=1, 2, \dots$$

Then, in order to show this, function $y=f(x)=1/x$ is considered. Since this function is convex to the starting point, when θ is set to $0 < \theta < 1$, as opposed to arbitrary 2 positive points: x_1 and x_2 , the following is realised.

$$\theta \cdot f(x_1) + (1-\theta) \cdot f(x_2) \geq f\{\theta \cdot x_1 + (1-\theta) \cdot x_2\}$$

(In the case of $x_1=x_2$, an equal mark is materialised.)

Next, if $x_4 = (x_2+x_3) / 2$ is placed with the arbitrary positive numbers x_1, x_2 , and x_3 , since

$$\theta \cdot f(x_1) + (1-\theta) \cdot f(x_4) \geq f\{\theta \cdot x_1 + (1-\theta) \cdot x_4\}$$

is realised, then

$$\frac{1}{3} \cdot f(x_1) + \frac{2}{3} \cdot f\left(\frac{x_2+x_3}{2}\right) \geq f\left(\frac{x_1+x_2+x_3}{3}\right) \text{-----}(2)$$

will be realised, when $\theta=1/3$.

Next, if both sides of the equation are multiplied by two thirds since it is clear to be set to

$$\frac{f(x_2)+f(x_3)}{2} \geq f\left(\frac{x_2+x_3}{2}\right)$$

to arbitrary positive number x_2 and x_3 , then

$$\frac{f(x_2)+f(x_3)}{3} \geq \frac{2}{3} \cdot f\left(\frac{x_2+x_3}{2}\right) = \frac{2}{3} \cdot f(x_4) \text{-----}(3)$$

is realised.

Therefore, according to (2) and (3),

$$\frac{f(x_1)+f(x_2)+f(x_3)}{3} \geq \frac{f(x_1)}{3} + \frac{2}{3} \cdot f\left(\frac{x_2+x_3}{2}\right) \geq f\left(\frac{x_1+x_2+x_3}{3}\right)$$

was shown.

Becoming

$$\frac{f(x_1)+f(x_2)+\dots+f(x_n)}{n} \geq f\left(\frac{x_1+x_2+\dots+x_n}{n}\right)$$

generally is shown by repeating the above method. (In the case of $x_1=x_2=\dots=x_n$, an equal mark is materialised).

When placed with $x_i=1/a_i$, $S>0$ is shown excluding a trivial case. (QED.)

In this way it is shown that social products increase by changing resource allocation from a person with low resource productivity to one with high resource productivity. Although the differences from 2.2.2 were a case where resource allocation was changed from two arbitrary persons who use different technology, and when the resource allocation of all the technology was changed, the same result was obtained in 2.2.3. An important thing is that the conclusion of the above-mentioned proposition does not change whether the owner of resources is a capitalist or a state.

This understanding enables a new socialist system interpretation.

2.2.4 Socialist system

The important conclusions of the preceding argument are as follows.

First, when there is a difference in resource (or labour) productivity among social members, unequal outcomes in production cannot be avoided, even if resource allocation is carried out equally.

Second, it is possible to make production increase on the whole by re-distributing many resources to a person with high productivity, even if there is no technical progress.

Third, these propositions are applicable regardless of the social systems.

Although it is well known that a system called ‘socialism’, as practised in today’s China or the former Soviet Union, for example, took measures such as nationalising the means of production and abandoning the private ownership system, and moved towards collectivism and cooperatisation, it cannot necessarily be said that the state-owned enterprise’s productivity is high, or that it has succeeded in management. Moreover, although each country underwent neo-liberal reform after the 1980s produced speculative capitalism was concluded as the global financial crisis, on the other hand, nationalisation and cooperatisation are points which have clearly been shown to be ineffective, and it has been concluded that this is their historical fixed meaning.

If looked at like this, nationalisation of means of production, collectivism, cooperatisation, and abandonment of the private ownership system will not necessarily be indispensable to socialism, and will not be inevitable. In the domain where public responsibility is high, and the fields (for example education, medical treatment, welfare, etc.) that require the accumulation of long-term information or human capability and its succession, state-owned enterprise will most likely be desirable. However, on the other hand, state-owned enterprise is also flawed in that it

has great difficulty with rational management subjects, such as dealing with challenges in a new field and personnel reduction (i.e. resuructuring). Moreover, in order to avoid the arbitrary nature of politics, it is thought that private forms of enterprise are necessary in order to stabilise corporate management autonomously. In addition, it would be possible to force corporate social responsibility or to make a public role through the acquisition of stock by the government, enforce control by a taxation system, etc., even if it is a company that pursues capitalist profits. Looked at this way, it seems that there is no basis to consider nationalisation of means of production, collectivism, cooperatisation, state-owned enterprise and abandonment of the private ownership system like an inescapably socialist proposition.

Then what is the ‘Merkmal’ that distinguishes socialism and capitalism? We think that it is chiefly the domain of product distribution rather than production. For example, it is thought that the following policies may distinguish socialism from capitalism:

- Distribution and the gap of income should be stopped within fixed limits.
- Companies should take fixed social responsibility about reservation of employment, or the determination of investment.

- A graduated taxation system should be introduced to the excessive profits obtained from dealing of a stock.
- Education and medical treatment should be offered free.
- An inheritance tax for reducing and controlling the gap between generations should be devised.
- Suitable training opportunities, or education and the opportunity of fair employment, should be given.
- Control should be added to human activity so that production and the environment can be maintained.
- Nuclear weapons, which threaten the survival of human beings, should be reduced, and their use should be forbidden.

The above problem domains are fundamentally problems of distribution, and contain the problem of value judgement such as the principle of socialist distribution: ‘From each according to his ability, to each according to his needs’ (Marx, K, 1875, Critique of the Gotha Programme). Socialism prepares a fixed solution (i.e. a series of policy systems based on a certain values and political ideas), comes to political power lawfully on the problems mentioned above, and implements a policy suitable for the idea. And when gradual reform is enacted, systems suitable for new ideas are made and become common property of a national large majority, gaining the support of a large national majority, it could be said that the true socialist system has truly

then materialised. We would like to understand such a socialist system as a thing of reality.¹

Section 3: Efficiency and sustainability

2.3.1 Social systems and efficiency

From the above consideration, whether a capitalist society or a socialist society, it is possible to think that a social system is a vehicle for leading people to the future. However, no matter what system it may aim at, impelling force is required to move the vehicle, and resources and products are required. The impelling force of this vehicle is material production and services, and is an economic domain. Therefore, one of the necessary conditions of a desirable society is attaining the minimum resources in the field of material production, the greatest at the minimum expense, and the greatest surplus products. In other words, it needs to attain efficient production in all corners of society. The second condition is the coexistence of the environment and economic activity: the realisation of sustainability. The second condition is considered in the following section. (Although some other necessary conditions can be considered besides these, their examination exceeds the subject of this book.)

¹ It is said that the ALP of Australia is at a stage of political reconstruction under the tradition as a socialist political party and the influence of neoliberalism. Refer to Boreham *et al.*, pp.46–7, 2004.

In order to attain the first condition, resource allocation must change according to the gap and technical progress of productivity as shown in Section 2 of this chapter. There are two methods of changing resource allocation: the regulation by law or a policy, and the market-based method. We would like to argue anew in the following chapter (Chapter 3) about the predominancy of the market-based method.

2.3.2 Social system and sustainability

One of the necessary conditions of future society is for the environment and economy to coexist: that is called sustainability. How should we aim for the coexistence of environmental preservation and economic activity? We think as follows.

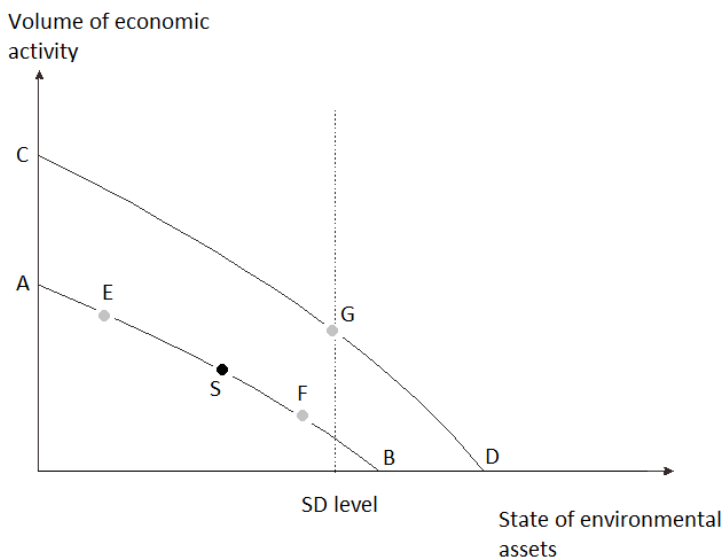


Figure 2.1: concept of sustainability and social system change

It is a generally accepted objective fact that production activity discharges various wastes and has negative influence on the environment in the short term and in the long run. Therefore, if the state of environmental assets is taken along the horizontal axis and the level of economic activity or an economic growth rate along the vertical axis, it will be thought that both have a trade-off relation, like the AB line. Supposing the present economy is on the point of S, the course in the direction of E is a path of self-destruction that does not take the sustainability of the environment and economic activity into consideration. On the other hand, a maintainable direction is F. However, F must be content with economic growth lower than the present.

On the other hand, the direction that can secure high economic growth is G, maintaining sustainability. However, in order to attain G, it is necessary to convert the relationship between environment and economy into CD from AB. If it is possible to change the present relation between environment and economy into another form, the conversion to CD from AB will be called a 'social system change'. It will become possible to realise economic growth and environmental preservation simultaneously over a long period of time.

It is thought that social system change does not stop at a technical meaning, but contains the whole and gradual change of a social system, including the conversion of the conventional

‘materialistic’ sense of values or political ideas. Australia is not necessarily getting the result that should be observed, especially for an OECD country, in economics as well as in fields such as energy-saving technologies, as is shown in Table 2.1. However, the evaluation will be reversed if looked at from the viewpoint of social system change mentioned above.

How is conversion of a social system attained concretely? Or, in other words, is sustainable growth possible? Chapter 11 considers the answer. It is also a subject of this book to search for a way to a society in which this continuation is possible.

	Per Capita GDP	Real Eco. Growth	Energy Efficiency	CO2 Emission	Nitrogen Fertilizer usage
Unit	US\$ 1989	%/year 1980-89	Oil equivalent ton/1000US\$-1988	% 1990	ton/farm land 100 ha-1988
Australia	17,033	3.80	0.47	1.2	—
Canada	20,528	3.68	0.64	2.0	2.6
France	17,008	2.49	0.37	1.7	13.3
Germany	18,980	1.91	0.41	4.5	20.6
Italy	15,053	2.44	0.32	1.9	7.6
Japan	23,298	4.75	0.27	5.1	13.7
Netherlands	15,227	1.72	0.48	0.7	46.7
Sweden	22,524	2.27	0.52	—	7.5
UK	14,913	3.09	0.41	2.6	20.9
USA	20,630	3.57	0.44	22.0	5.1
USSR	—	—	—	18.7(1988)	—
Source	UN Year Book	UN Year Book	OECD State of Environment	PBL Report	OECD State of Environment

Table 2.1: international comparison of economy and environment

(Source: Kondo, 1995a, p.39 and PBL 2012 report, p.28.

Note: according to the PBL report, the ratio which China occupies to the carbon-dioxide emissions in the world was 11 per cent in 1990 and 28.6 per cent in 2011)

Chapter 3

Technical Backgrounds of Water Trading and Markets

This chapter attempts to clarify the concept of analysing water markets and to develop a fundamental tool for this process. Specifically, an understanding of this basic economic concept is improved by setting the derivation of a water demand curve or a water supply curve last. For this reason, in Section 1 we show how a linear model generally demonstrates the profits of exchange. Then, in Section 2, we discuss and expand the argument for a nonlinear model. In Section 3, we introduce the monetary utility function and explain the important concept of a marginal rate of substitution and Pareto optimality. In Section 4 we discuss and derive the functions of water demand and water supply. In Section 5, we integrate the arguments from Section 3 and Section 4 and develop the theory of an expected price, bearing a water market in mind. Section 6 illustrates the profits of water markets in two ways. In Section 7, we explain the Coase theorem. The arguments presented in this entire chapter are summarised in Section 8.

Section 1: Profits of division of labour and exchange (linear model)

Adam Smith showed that a society with division and exchange of labour could achieve greater affluence in material production than a society based on self-sufficiency.

Let's interrogate this assumption.

Free producers, set to 'Mr 1' and 'Mr 2' now, make two types of product, 'a' and 'b', and the quantity of production is written as Q_a and Q_b . For Mr 1 to produce one unit of goods 'a', he only needs τ_{a1} labour, and for Mr 1 to produce one unit of goods 'b', he only needs τ_{b1} labour. Similarly, for Mr 2 to produce one unit of goods 'a', he only needs τ_{a2} labour, and for Mr 2 to produce one unit of goods 'b', he only needs τ_{b2} labour. The tau is called a labour input coefficient (= labour input / quantity of production). The labour quantity which everybody can drop is presented as 'L'. (We assume that goods other than labour required for production fully exist).

At this time, we settle the combination (production set) of the goods Q_a and Q_b which can be produced by Mr 1 and Mr 2 as follows (refer to Figure 3.1).

Mr 1's production set

$$= \{(Q_{a1}, Q_{b1}) \mid \tau_{a1} \cdot Q_{a1} + \tau_{b1} \cdot Q_{b1} \leq L, Q_{a1} \geq 0, Q_{b1} \geq 0\},$$

Mr 2's production set

$$= \{(Q_{a2}, Q_{b2}) \mid \tau_{a2} \cdot Q_{a2} + \tau_{b2} \cdot Q_{b2} \leq L, Q_{a2} \geq 0, Q_{b2} \geq 0\}.$$

All the combinations from two production sets produce results in the following two cases without losing generality, if we assume that the labour-input coefficient changes with everybody. The line segment of the direction of a northeast part of a production set is called a 'producible (or production) frontier'.

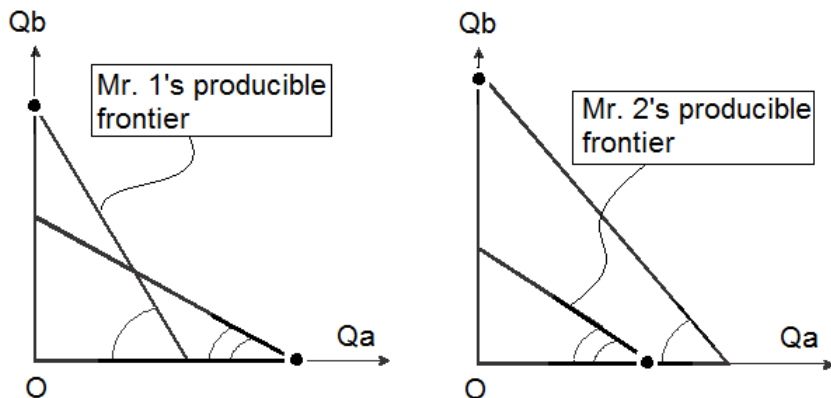


Figure 3.1: possible combinations of production sets
 (Note: the slope of Mr 1's producible frontier : $\tau a1/\tau b1$.
 The slope of Mr 2's producible frontier : $\tau a2/\tau b2$)

While both producible frontiers intersect in the first quadrant of the left-hand part of Figure 3.1, there is no intersection in the right-hand part of Figure 3.1.

When there is no market and no exchange, each producer cannot but choose one point on each producible frontier.

However, people can enjoy a higher producible frontier by exchanging surplus products to markets.

In order to show this, it is assumed that Mr 1 has a comparative advantage in production of the goods 'b', and that Mr 2 has a comparative advantage in production of the goods 'a'. This means $\tau_{a1}/\tau_{b1} > \tau_{a2}/\tau_{b2}$. That is, Mr 1 can produce τ_{a1}/τ_{b1} unit of goods 'b' using the labour surplus, since one unit of production of the goods 'a' was given up. Mr 2 can produce τ_{a2}/τ_{b2} units of goods 'b' using the labour surplus since one unit of production of the goods 'a' was similarly given up. Since it is $\tau_{a1}/\tau_{b1} > \tau_{a2}/\tau_{b2}$, it is said that Mr 1 exceeds Mr 2 in production of the goods 'b'.

In this case, Mr 1 specialises in production of the goods 'b', and Mr 2 specialises in production of the goods 'a' and a mutual exchange of goods becomes more advantageous to both sides.

However, the exchange rate Q_b/Q_a of the goods 'a' and the goods 'b' must fulfill the following conditions:

$$\tau_{a2}/\tau_{b2} < Q_b/Q_a < \tau_{a1}/\tau_{b1} \text{-----}(1)$$

When the exchange rate of goods fulfills the conditions of (1), if Mr 2 parts with one unit of goods 'a', when producing the goods 'b' himself, only τ_{a2}/τ_{b2} units can be produced, but the goods 'b' beyond it can be gained by exchange.

On the contrary, if Mr 1 parts with one unit of goods 'b', when producing the goods 'a' by himself, only τ_{b1}/τ_{a1} units can

be produced, but the goods 'a' beyond it can be gained by exchange. (From (1), it is cautious of $Q_a/Q_b > \tau_{b1}/\tau_{a1}$ being realised (refer to Figure 3.2).

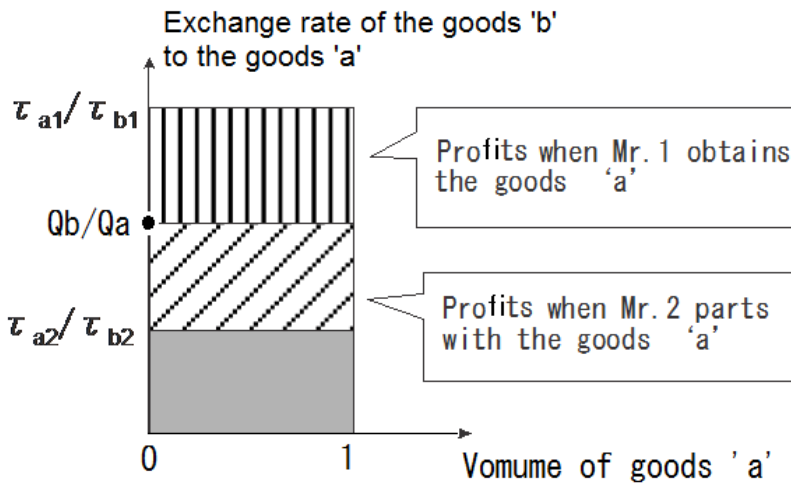


Figure 3.2: profits of both sides at the time of trading in one unit of goods 'a'

Therefore, Mr 1 can choose a state higher than the frontier of the producible set by continuing to part with the goods 'b' and continuing to gain the goods 'a' (this exchange can expand its producible set). Mr 2 is the same. When all of Mr 1's labour is applied to production of the goods 'b', the maximum production size is L/τ_{b1} . Similarly, when all of Mr 2's labour is applied to production of the goods 'a', the maximum production size is L/τ_{a2} . Since the dropping labour quantity of the goods 'a' and the goods 'b' is equal (i.e. L), according to the labour theory of

value, if there is an exchange in maximum production size $L/\tau b_1$ of Mr 1's goods 'b' and maximum production size $L/\tau a_2$ of Mr 2's goods 'a', and the exchange rate assumes when it comes to $Q_b/Q_a = \tau a_2/\tau b_1$, the frontier of each production set and the domain of a production set created by the exchange become as shown in Figure 3.3.

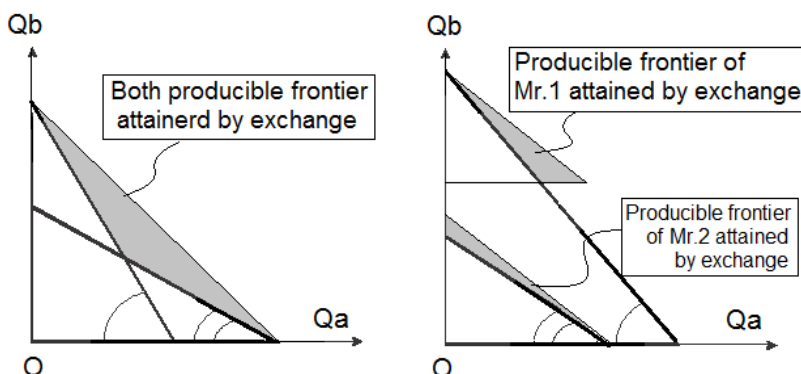


Figure 3.3: profits of division of labour and exchange (linear case)

When each of the producible frontiers do not have an intersection by the first quadrant, it becomes as in the right part of Figure 3.3. It is clear that the producible frontier was expanded in any case and both material positions have been improved by the exchange. That is, the free exchange based on division of labour can make both sides shift to the position where it exceeds the economic target.

If exchange contains such a universal economic merit, the development of a social division of labour and the expansion of markets are understood as a very natural social development. Similarly, a socialist system should discard neither exchange nor a general market but should be a society based on an exchange or a general market.

Section 2: Profits of division of labour and exchange (nonlinear model)

Section 1 discussed the profits of exchange on the assumption of a barter economy between producers and a linear production function.

Next, we will introduce a nonlinear production and utility function and advance an argument for a barter economy in which irrigation farming becomes the leading role of exchange.

3.2.1 Production planning of an irrigation farmer

It is assumed that water is indispensable to production. In the case of irrigation agriculture, the production function for crop 'a' and crop 'b' of the producer concerned will be written to be 'f' and 'g' respectively.

Namely, they are:

$$Q_a = f(wa), \quad dQ_a/dwa > 0, \quad d^2Q_a/dwa^2 \leq 0,$$

$$Q_b = g(wb), \quad dQ_b/dwb > 0, \quad d^2Q_b/dwb^2 \leq 0.$$

Here, Q_a is the quantity of production of the crop 'a', Q_b is the quantity of production of the crop 'b', and ' w_a ' and ' w_b ' are the water that was supplied to the production of crop 'a' and crop 'b' respectively.

For the producer concerned, the amount of water (i.e. the distribution water based on water rights) which can be used will be defined in advance, and we will write it as \bar{w} .

Namely, it is realised as:

$$w_a + w_b \leq \bar{w} (= \theta \cdot E).$$

(When there is a probable inconsistency between the water rights E and total distribution water \bar{w} by a drought etc., \bar{w} changes to $\theta \cdot E$. θ is an announced distribution rate).

We will first consider an economy of self-sufficiency without exchange. Using limited water resources and labour, producer 1 has to plan the production. We will assume that labour is not limited and that water resources are the only restricted factor of production. (That labour is not limited says that the quantity of production supplied and produced by the total amount of water is smaller than the maximum quantity of production which is supplied and produced by all the labour).

Then, the problem which this producer should solve could be written as follows:

$$u = u(Q_a, Q_b) \rightarrow \text{maximise}$$

$$\text{Subject to: } w_a + w_b \leq \bar{w},$$

$$Q_a = f(w_a), Q_b = g(w_b).$$

$u(\cdot)$ is a utility function of an irrigation farmer here. The form of the utility function is assumed supposing the standard type is realised as:

$$\frac{\partial u}{\partial Q_a} > 0, \frac{\partial u}{\partial Q_b} > 0, \frac{\partial^2 u}{\partial Q_a^2} < 0, \frac{\partial^2 u}{\partial Q_b^2} < 0.$$

(The actuality of this assumption and the economic ground are examined separately).

Next, this producer's producible frontier is the following curve:

$$\{Q_a, Q_b\} = \{(f(w_a), g(\bar{w} - w_a))\}$$

That is, the production at the time of the water being used to produce the goods 'a' and the goods 'b'. If the inverse function of f and g is written to be f^{-1} and g^{-1} , this producer's production frontier curves can be written as:

$$f^{-1}(Q_a) + g^{-1}(Q_b) = \bar{w}.$$

Then, the slope (dQ_b/dQ_a) of a production frontier curve will be calculated to:

$$dQ_b/dQ_a = -\frac{(f^{-1})'}{(g^{-1})'} < 0, \text{-----(2)}$$

$$\text{by considering } f' \cdot (f^{-1})' = 1.$$

Furthermore, when this formula (2) is differentiated from Q_a , it comes to:

$$d^2 Q_b / d Q_a^2 = - \left((f^{-1})'' \cdot (g^{-1})' - f' \cdot (g^{-1})'' \cdot \frac{d Q_b}{d Q_a} \right) / ((g^{-1})')^2.$$

Then by considering:

$$\frac{d Q_b}{d Q_a} = - \frac{g'}{f'}, (f^{-1})'' > 0, (g^{-1})'' > 0,$$

it becomes:

$$d^2 Q_b / d Q_a^2 < 0.^1$$

Therefore, the northeast frontier of a production set becomes concave to the starting point, as shown in Figure 3.4.

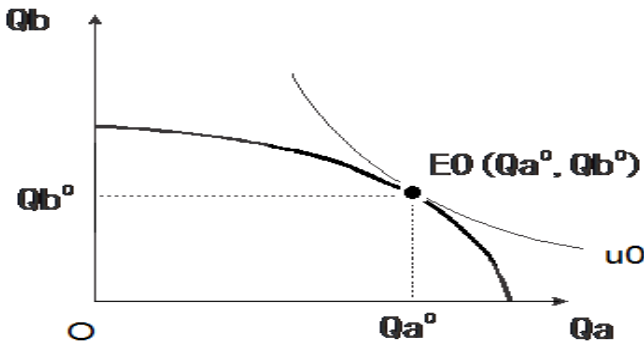


Figure 3.4: production frontier (non-linear case) and indifference curve

¹ The reason we used $d^2 Q_b / d Q_a^2 < 0$ is as follows. If seen from producer 1, when a lot of goods 'a' exist, water's marginal productivity f' of the goods 'a' is small. However, when water is moved from the goods 'a' and the goods 'b' are made using this water, water's marginal productivity g' of the goods 'b' is large. Therefore, although the substitution effect when one unit of goods 'a' is reduced and the goods 'b' are made as large as $-d Q_b / d Q_a = \frac{(f^{-1})'}{(g^{-1})'} = \frac{g'}{f'}$ at first, the effect becomes small as the quantity of production of goods 'b' increases (i.e., as the quantity of production of the goods 'a' decreases).

On the other hand, as the producer's indifference curve u_0 is shown in Figure 3.4, supposing it is given, this irrigation farmer's planning of production will become settled like point $E_0 = (Q_a^0, Q_b^0)$ of Figure 3.4. Planning of production can be similarly defined for producer 2.

3.2.2 Profits of division of work and exchange (non-linear case)

Next, we consider the situation where barter is performed by the producers. Supposing that producer 1 and producer 2 exchange, we suppose that each production set has the appearance of Figure 3.5.

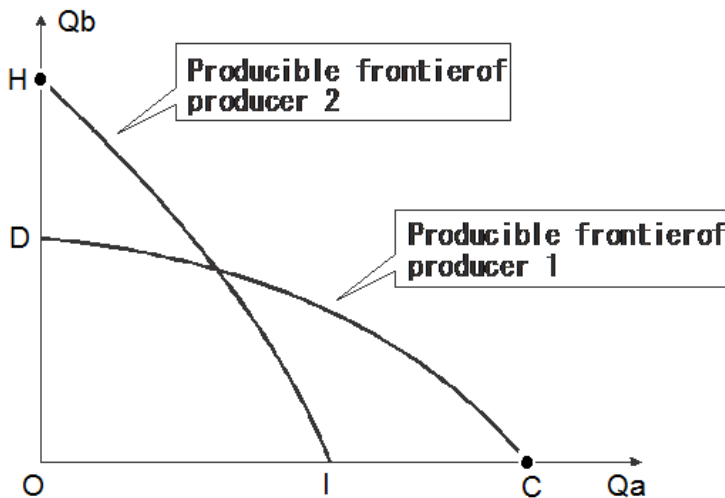


Figure 3.5: reducible frontiers (non-linear case)

If producers 1 and 2 are compared, producer 2's comparative productivity of goods 'a' to goods 'b' (OH/OI) is greater than the producer 1's comparative productivity (OD/OC). That is, producer 1 has a comparative advantage in production of goods 'a', and producer 2 has a comparative advantage in production of goods 'b'. Then, producer 1 will specialise in production of goods 'a', and producer 2 will exchange by specialising in production of goods 'b'. In that case, what do the profits of exchange become?

Producer 1 gives up production of goods 'a', and only OD is producible supposing all the water is assigned to production of goods 'b'. Therefore, the exchange rate (written as Qb/Qa) of goods 'a' to goods 'b' if seen from producer 1 should be $OD/OC < Qb/Qa$.

Similarly for producer 2 only OI is producible supposing production of goods 'b' is given up and all the water is assigned to the production of goods 'a'. Therefore, for producer 2, if the exchange rate of goods 'b' to goods 'a' will not realise $OI/OH < Qa/Qb$, it will not answer the exchange.

In order to satisfy both these demands, the exchange rate of goods 'b' to goods 'a' (i.e. Qb/Qa) should just fulfil the condition becoming:

$$OD/OC < Qb/Qa < OH/OI, \text{-----}(3)$$

is measured downward. Although the production set of producer 1 remains as it is, producer 2's production set is changed into a point $(Q_a, Q_b) \rightarrow \text{point } (\overline{Q_a} - Q_a, \overline{Q_b} - Q_b)$ (refer to Figure 3.6).

In Figure 3.6, if a certain point of the domain outside both producers' production sets, for example point E1, is chosen, the absolute value of the slope of the straight line that connects point E1 and point C fulfils the conditions as follows:

$$O1D/O1C < \text{absolute value of slope of line CE1} < O2C/O2I.$$

When producer 1 parts with $\overline{Q_a} - Q_a^*$ of goods 'a', producer 1 can get the goods 'b' only:

$$(\text{absolute value of slope of line CE1}) \times (\overline{Q_a} - Q_a^*) = Q_b^*.$$

In other words, producer 1's producible frontier was expanded to CE1 from curvilinear CD.

Since this ratio is $O1H/O1C$, supposing it is decided that an exchange rate will be $\overline{Q_b}/\overline{Q_a}$, as for this ratio, the bargaining condition (3) is clearly fulfilled. In this case, both producers' producible frontiers are expanded as shown in Figure 3.7.

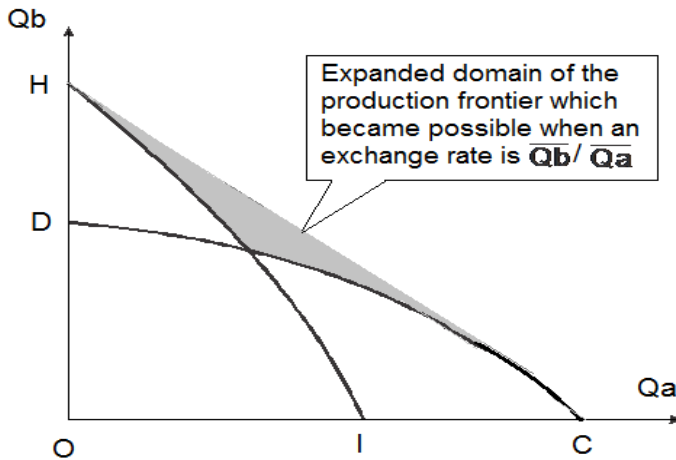


Figure 3.7: profits of division of labour and exchange (non-linear case)

Moreover, it is also clear for producer 1 that the point E1's utility level is increasing from before as shown in Figure 3.8:

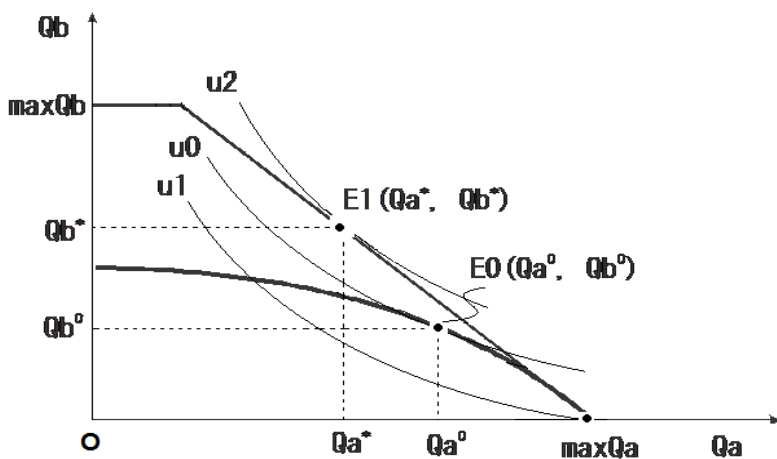


Figure 3.8: change of the utility level by exchange

MaxQb here assumes the case where producer 2's goods 'b' temporarily become zero, when producer 1 exchanges the goods 'a' by an exchange rate $\overline{Q_b}/\overline{Q_a}$ and gains the goods 'b'. That is, the quantity of the greatest goods 'b' that producer 1 can gain is expressed.

Let us check producer 1's increase in utility level by exchange. Point E0 is the maximum point of utility at the time of self-sufficiency. The utility level at this time is set to u_0 . Although producer 1's utility level falls to u_1 from u_0 once by specialising in self-sufficient production of goods 'a', as long as an exchange rate is advantageous to both sides, producer 1's utility level eventually rises to the level of u_2 , and the utility level clearly improves ($u_0 < u_2$). This is also the same for producer 2.

Here, one problem arises. As stated, until now, as long as the exchange rate fulfilled certain conditions, it was clear that both sides received certain profits by exchange. However, the issue of how the exchange rate is decided is overlooked. In order to consider this problem, it is necessary to stand on an indifference curve once again.

Section 3: Pareto optimality of the market economy

In Section 2 exchanges are performed by producers and the profits of exchange are considered in the context of mutual

bartering. The profits of exchange in the developed market economy, where money is used for exchange, are considered shortly. The issue here will be to determine the demand curve and supply curve of water.

3.3.1 Monetary utility function and marginal rate of substitution

In order to understand how a price is decided in the market economy, it is necessary to go back to a utility function. We explain this using a ‘monetary utility function’ (also called ‘quasi-linear preferences’). The monetary utility function is excellent not for evaluating an ambiguous quantity of the unit of utility, but for deciding the use which certain goods bring about with currency amount (Robson, 2011, p.61).

Participants in markets exchange money for goods, whether or not they are producers. Sellers get money for parting with goods; buyers part with money and gain goods. Therefore, a seller is going to hope to receive as much money as possible when losing goods and a buyer is going to want to gain goods in exchange for the smallest possible amount of money. There must therefore be a criterion to assess the money exchanged.

A seller’s case is considered first. A seller possesses \bar{Q} units of certain goods, or the maximum quantity that can be shipped, and assumes only the Q of these will be sold. Therefore, $\bar{Q} - Q$

is the amount of stocks after sale (or inventory volume).

Probably, at this time, the money amount (or expected amount of earnings by sale of $(\bar{Q} - Q)$ appraised to the stock goods of a $\bar{Q} - Q$ unit exists subjectively. This is written with B_s . Since B_s is considered to change according to a quantity on hand, it can be written to be $B_s = B_s(\bar{Q} - Q)$.

About the character of B_s , it is conformably assumed as $0 = B_s(0)$, $B_s' > 0$, and $B_s'' < 0$ with the character of a utility function.

It is the average amount appraised (or expected average earnings by sale) p_s^a which divides B_s by the amount of stocks. That is, since it is $p_s^a = B_s / (\bar{Q} - Q)$, p_s^a also serves as a function of $(\bar{Q} - Q)$.

It is set to $\frac{dp_s^a}{d(\bar{Q} - Q)} < 0$, $\frac{d^2 p_s^a}{d(\bar{Q} - Q)^2} > 0$ from the character of B_s .

Namely, it is set to:

$$B_s = p_s^a(\bar{Q} - Q) \cdot (\bar{Q} - Q), p_s^a = p_s^a(\bar{Q} - Q) > 0, \quad \frac{dp_s^a}{d(\bar{Q} - Q)} < 0,$$

$$\frac{d^2 p_s^a}{d(\bar{Q} - Q)^2} > 0. \quad \text{-----}(4)$$

Next, the subjective amount appraised in case a seller loses one unit of the amount of stocks (or expected marginal earnings) serves as:

$$B_{s'} = \frac{dB_s}{d(\bar{Q} - Q)} = \frac{dp_s^a}{d(\bar{Q} - Q)} \cdot (\bar{Q} - Q) + p_s^a. \text{-----}(5)$$

(4) and (5) show that a seller's expected marginal earnings are smaller than expected average earnings. And Bs' expresses the size of the monetary earnings expected by the sale of one unit of goods.

In the case of a buyer it is assumed that Q unit purchase of the goods is carried out. In this case, there probably exists an expected expense (or subjective evaluation in terms of money of the satisfaction obtained by the purchase of Q) that may pay for the purchase of Q . This will be written to be Bd . Since Bd is considered to be a function of the amount Q of purchase, they can be written to be $Bd=Bd(Q)$ and $0=Bd(0)$. Furthermore, it is conformably assumed as $Bd'>0$ and $Bd''<0$ with a utility function about the character of Bd .

If the average amount appraised if only Q purchases goods (expected average expense for purchase) is written to be p_D^a like a seller's argument, p_D^a will serve as a function of Q and will be set to $Bd=p_D^a(Q) \cdot Q$ and $p_D^a(Q)>0, \frac{d p_D^a}{d Q}<0$.

Namely, it is set to:

$$Bd=p_D^a(Q) \cdot Q, p_D^a = p_D^a(Q)>0, \frac{d p_D^a}{d Q}<0, \frac{d^2 p_D^a}{d Q^2} < 0. \text{-----}(6)$$

Next, the subjective amount appraised in case a seller loses one unit of stock (or the expected marginal expense for purchase) serves as:

$$Bd' = \frac{dBd}{dQ} = \frac{dp_D^u}{dQ} \cdot Q + p_D^a. \text{-----} (7)$$

A buyer's amount of a marginal payment intention is smaller than the amount of an average payment intention from (6) and (7). And, Bd' expresses the satisfactory size (estimated money) expected by the purchase of one unit of goods.

Next, the monetary utility function of a seller and a buyer can be written as follows by considering the above as preparation:

(In the case of a seller)

$$\begin{aligned} uS &= uS (\bar{Q} - Q, Ms) = Bs (\bar{Q} - Q) + Ms \\ &= p_S^a \cdot (\bar{Q} - Q) + Ms \text{-----} (8) \end{aligned}$$

(In the case of a buyer)

$$\begin{aligned} uD &= uD (Q, Md) = Bd (Q) + Md \\ &= p_D^a \cdot Q + Md \text{-----} (9) \end{aligned}$$

Ms is the quantity of money that the seller holds and Md is the quantity of money the buyer holds.

Namely, as for this monetary utility function, the more the total of the appraised goods and the amount of money possessed increases, the more the degree of satisfaction will rise.

The marginal utility of goods as a natural assumption about a utility function is positive and we think it will decrease gradually.

Namely, it is assumed that:

$$\frac{\partial u_S}{\partial (\bar{Q}-Q)} = \frac{\partial p_S^a}{\partial (\bar{Q}-Q)} \cdot (\bar{Q}-Q) + p_S^a = B_S' > 0, \frac{\partial^2 u_S}{\partial (\bar{Q}-Q)^2} = B_S'' < 0$$

----- (10)

$$\frac{\partial u_D}{\partial Q} = \frac{\partial p_D^a}{\partial Q} \cdot Q + p_D^a = B_D' > 0, \frac{\partial^2 u_D}{\partial Q^2} = B_D'' < 0$$

----- (11)

is realised. (10) and (11) show that each marginal utility is equal to subjective money evaluation (expected price) of goods.

Next, an **indifference curve** is a combination of a point (Q, Ms) or a point (Q, Md) which sets a utility level with, for example, $u_0 = u_S(\bar{Q}-Q, M_S)$ or $u_1 = u_D(Q, M_D)$, by which, respectively, it fulfils this fixed utility level. A **marginal rate of substitution** (MRS) can be defined as an indifference curve.

With a marginal rate of substitution, it is defined as the slope of an indifference curve. When utility functions are (8) and (9), a seller's marginal rate of substitution is set to:

$$MRS_{\bar{Q}-Q, M_S}^S = \frac{\partial u_S / \partial (\bar{Q}-Q)}{\partial u_S / \partial M_S} = \frac{\partial u_S}{\partial (\bar{Q}-Q)}$$

$$= \frac{\partial p_S^a}{\partial (\bar{Q}-Q)} \cdot (\bar{Q}-Q) + p_S^a = B_S' > 0. \text{----- (12)}$$

And, a buyer's marginal rate of substitution is set to:

$$MRS_{Q, M_D}^D = \frac{\partial u_D / \partial Q}{\partial u_D / \partial M_D} = \frac{\partial u_D}{\partial Q} = \frac{\partial p_D^a}{\partial Q} \cdot Q + p_D^a = B_D' > 0. \text{----- (13)}$$

Note that monetary marginal utility, that is, $\frac{\partial u_S}{\partial M_S}$ and $\frac{\partial u_D}{\partial M_D}$, are 1, respectively. A marginal rate of substitution is decided by this model regardless of money level. That is, each MRS is equal to

each marginal utility and each marginal utility is equal to each expected price (see equation [10] and [11]).

If the assumption about p_S^a and p_D^a , i.e. (4) and (6), is taken into consideration, generally each marginal rate of substitution curve will become as shown in Figure 3.9. Namely, a buyer's marginal rate of substitution curve becomes a downward slant to the right, and a seller's marginal rate of substitution curve becomes an upward slant to the right as shown in Figure 3.9.

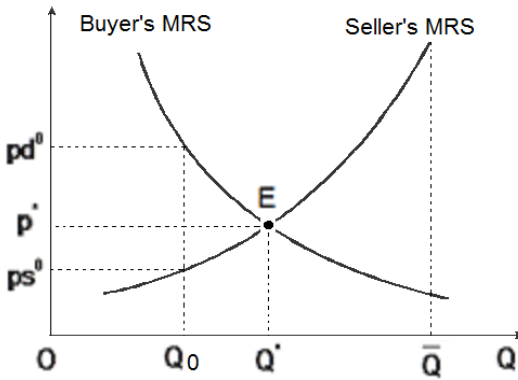


Figure 3.9: typical marginal rate of substitution curves and determination of a market equilibrium point

(Note: seller's MRS curve is $MRS_{Q,M_S}^S = \frac{\partial p_S^a}{\partial (\bar{Q} - Q)} \cdot (\bar{Q} - Q) + p_S^a = Bs'$,

and buyer's MRS curve is $MRS_{Q,M_D}^D = \frac{\partial p_D^a}{\partial Q} \cdot Q + p_D^a = Bd'$)

In this way, an **equilibrium point** (E) will be decided by both spontaneous negotiations if the marginal rate of substitution curve of a seller and a buyer is given. That is, an

exchange rate with the cost of goods, i.e. market price p^* , and trading volume Q^* are decided simultaneously.

Example:

A seller's utility function is set to:

$$\begin{aligned} u_S &= u_S(\bar{Q} - Q, M_S) = p_S^a \cdot (\bar{Q} - Q) + M_S \\ &= (a - b \cdot \ln(\bar{Q} - Q)) \cdot (\bar{Q} - Q) + M_S. \end{aligned}$$

A buyer's utility function is set to:

$$\begin{aligned} u_D &= u_D(Q, M_D) = p_D^a \cdot Q + M_D \\ &= (a' - b' \cdot \ln(Q)) \cdot Q + M_D. \end{aligned}$$

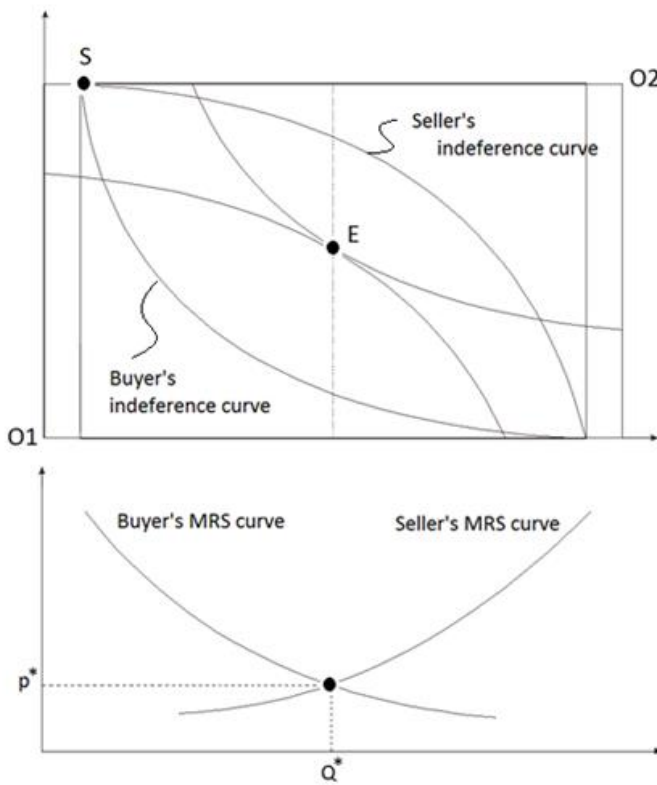
Moreover, each parameter and variables are set up as:

$$a = a' = 160, b = b' = 40, \bar{Q} = 20, M_S + M_D = 500.$$

That is, the goods that are the targets of dealings make a quantity of twenty units and of money 500 units at the maximum.

A buyer's origin is $O_1 = (0, 0)$ and a seller's origin is $O_2 = (20, 500)$. The state of the beginning (i.e starting point) of exchange is assumed as follows. A seller owns nineteen units of goods and the amount of money held is zero units. On the other hand, a buyer owns one unit of goods and assumes that money is held at 500 units. Therefore, the starting point S of negotiation is set to (1, 500). Each utility level in the starting point S is set to $u_S(19, 0) = 802.2$ and $u_D(1, 500) = 660$. Using the Edgeworth diagram,

each indifference curve in the starting point S is drawn, as shown in Figure 3.10.



**Figure 3.10: illustration of example
(Edgeworth diagram and MRS curves)**

Next, when a marginal rate of substitution is searched for, it is set to:

$$\begin{aligned}
 MRS_{\bar{Q}-Q, Ms}^S &= (a-b) - b \cdot \ln (\bar{Q}-Q) \\
 &= 120 - 40 \cdot \ln (20-Q) ,
 \end{aligned}$$

$$MRS_{Q,MD}^D = (a' - b') - b' \cdot \ln(Q) = 120 - 40 \cdot \ln(Q) .$$

Therefore, each marginal rate of substitution curve becomes as shown in the lower part of Figure 3.10.

Next, we need an equilibrium point. It will be set to $Q^*=10$, if set with $MRS_{\bar{Q}-Q,Ms}^S = MRS_{Q,Md}^D$ and the equilibrium quantity Q is calculated. Moreover, the market equilibrium price at this time is set to $p^*=27.9$.

In addition, the contract curve in the case of this example is set to $Q = \frac{\bar{Q}}{2} = 10$. For more information on contract curves, please refer to any standard micro-economics text.

Next, we will check how the utility level has changed before and after these dealings. In this example, the marginal rate of substitution is unrelated to a money level. When a money level is taken into consideration, a utility level is as follows:

At the point S:

$$(\text{Seller}) u_S = u_S(\bar{Q} - Q, M_s) = u_S(19, 0) = 802,$$

$$(\text{Buyer}) u_D = u_D(Q, M_d) = u_D(1, 500) = 660,$$

At the point E:

$$(\text{Seller}) u_S = u_S(\bar{Q} - Q, M_s) = u_S(10, 251.1) = 930 \text{ (the amount of money held is set to } M_s = 27.9 \times 9 = 251.1)$$

$$(\text{Buyer}) u_D = u_D(Q, M_d) = u_D(10, 248.9) = 927.8 \text{ (the amount of money held is set to } M_d = 500 - 251.1 = 248.9)$$

	Point S	Point E
Seller's utility level	802	930
Buyer's utility level	660	927.8

If the utility level of point S and point E are compared, if both seller's and buyer's utility levels are measured with the currency amount, both will increase clearly. Since at least one of the utility levels fall points is other than the point E, the point E is the optimal point in the meaning of Pareto. In other words, free dealings of the market economy can reach the **Pareto optimal** state automatically. ■

The above examination in Section 3 is summarised as follows. The marginal rate of substitution curve of a seller and a buyer can be derived by introducing a monetary utility function. These curves not only express the supply curve and the demand curve, but also express the expected price of a seller and a buyer, and can be used to determine the equilibrium point in the market economy.

To determine an equilibrium point, the demand curve must become a downward slant to the right and the seller's supply curve must become an upward slant to the right. The intersection of the demand curve and supply curve is the market equilibrium

point, and it was shown that the market equilibrium point is the Pareto optimum.

The remaining problem is to examine the expected price of water. As shown later, this is considered the inverse function of a water demand function or a water supply function. Therefore, considering an expected price of water requires consideration of a water demand function and a water supply function.

Furthermore, as we will explain later, a water supply function can be derived from a water demand function. We will consider derivation of a water demand function as the most important problem. Next, a water demand function is drawn, bearing a water market in mind.

Section 4: Derivation of a water demand function and a supply function

In this section, each exchange participant is an irrigation farmer who specialises in production and pursues the maximisation of profit instead of utility. As a production function, q : production per one unit of land (for example, one hectare) is an increasing function of water, and it is assumed that the marginal productivity of water is decreased gradually. That is, it is assumed:

$$q = f(w), f' > 0, f'' < 0 \text{ -----(14)}$$

is realised. Here, 'w' is the amount of water injection for one unit of land and, when the whole water demand of the irrigation farmer concerned is written to be W, it is $w=W/(\alpha \cdot L)$. Here, L means the land area which a farmer holds or manages. α is an actual usage rate of land. ($0 \leq \alpha \leq 1$) f is again a production function of the water for each unit of land.

The total profits Π is taken as

$$\Pi = \{p \cdot q - (c_1 \cdot q + p_w \cdot w) - c_0\} \cdot \alpha \cdot L.$$

Here, p is a unit price of products, q is the quantity of production per land, p_w is a unit price of water injection, and c_1 is the average variable costs other than water expense for one unit of product. w is the amount of water injection for one unit of land, and c_0 is constant expenses for one unit of land. The amount of water (w) injected is defined by the amount of water distributed based on water entitlements, and the amount of water purchased from a water market. If it accepts that the amount of water distributed based on water entitlements is decided when an irrigation farmer forms plans of production, the expense of the water distributed based on water entitlements will turn into a constant expense and will become the same form as the upper formula.

Since it is

$$\Pi = [p \cdot f(w) - \{c_1 \cdot f(w) + p_w \cdot w\} - c_0] \cdot \alpha \cdot L,$$

profits of one unit of lands: $\pi = \Pi/\alpha \cdot L$ serves as

$$\pi = NE - p_w \cdot w = \{ (p - c_1) \cdot f(w) - c_0 \} - p_w \cdot w \quad (15)$$

anew. Here, NE is net earnings per land and equal to

$$(p - c_1) \cdot f(w) - c_0.$$

The production determination of an irrigation farmer is as in Figure 3.11.

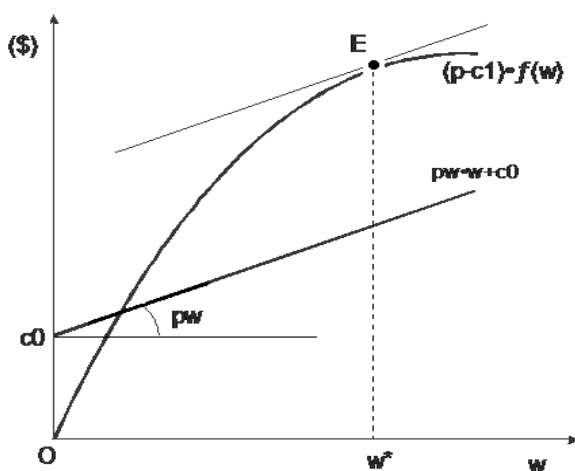


Figure 3.11: production determination of irrigation farmer

Since the profit's maximum point turns into the point of filling

$$(p - c_1) \cdot f'(w) = MNE(w) = p_w, \text{ the water amount demanded,}$$

w , per one unit of land can be found with

$$w = DL(p - c_1, p_w) = MNE^{-1}(p_w), \quad \frac{\partial DL}{\partial (p - c_1)} > 0, \quad \frac{\partial DL}{\partial p_w} < 0 \quad \text{-----} (16)$$

as a function of $p - c_1$ and p_w from this. Here, DL is a water demand function per one unit of land and MNE is a marginal net earnings function ($MNE = dNE/dw$) and this is exactly the inverse function of DL .

The water demand, which was found in (16), can be considered to be the quantity of water through the whole irrigation season. If the period of an irrigation season is set to $[0, T]$, in order to consider the water demand at each time (almost all the weeks of an irrigation season), it is necessary to consider the water demand distribution function $\varphi(t)$. This is a function showing the distribution of the amount of water, which has the character of $\int_{t=0}^T \varphi(t) \cdot dt = 1$ and the irrigation season for each of the crops. For example, the planting time differs according to crops and $\varphi(t)$ reflects the difference in the pattern of water demand according to the season as shown in Figure 3.12.

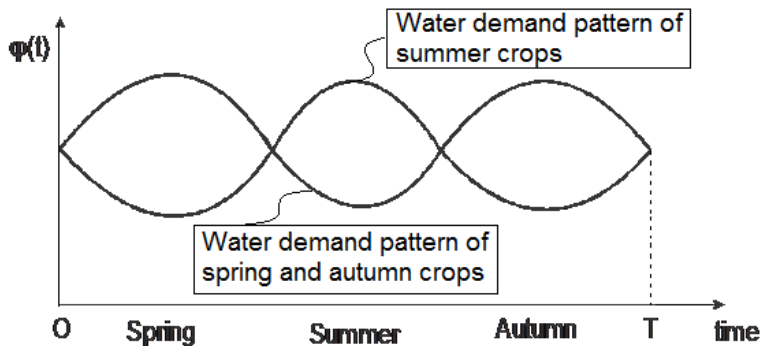


Figure 3.12: water demand distribution function

We will assume this water demand pattern is decided by crops. Then, the water demand at each time: $D(t)$ can be written to be

$$D(t) = \varphi(t) \cdot DL(p - c_1, p_w) \cdot \alpha \cdot L. \text{-----}(17)$$

If the product price: p , the other input-goods variable costs: c_1 , the water price: p_w , a water demand distribution function: $\varphi(t)$, the water entitlements: E , and prospect (water supply rate) of the distribution of water in the current fiscal year: θ are given, water-amount demanded: w^* and quantity of production per unit of land: $f(w^*)$ will be decided for this year. Furthermore, supposing it determines the capacity factor α of land ($0 \leq \alpha \leq 1$), the total profits of this irrigation farm are as follows.

$$\Pi^* = \{ (p - c_1) \cdot f(w^*) - (p_w \cdot w^* + c_0) \} \cdot \alpha \cdot L.$$

Moreover, as for amount of water required at each time, it is decided as

$$D(t) = \varphi(t) \cdot DL(p - c_1, p_w) \cdot \alpha \cdot L.$$

Therefore, a water deficit at the time of irrigation: $WD(t)$ can be written as follows:

$WD(t)$ = amount of water required at t — amount of water secured at $t = D(t) - \theta \cdot E$

$$= \varphi(t) \cdot DL(p - c_1, p_w) \cdot \alpha \cdot L - \theta \cdot E. \text{-----}(18)$$

Similarly, a water surplus at the time of irrigation: $WS(t)$ can be written as follows:

$$WS(t) = \text{amount of water secured at } t - \text{amount of water required at } t = \theta \cdot E - D(t)$$

$$= \theta \cdot E - \varphi(t) \cdot DL(p - c_1, p_w) \cdot \alpha \cdot L \text{-----(19)}$$

When a water price is taken along the vertical axis, the amount of water is taken along the horizontal axis, and WD function and WS function are drawn, it is as shown in Figure 3.13.

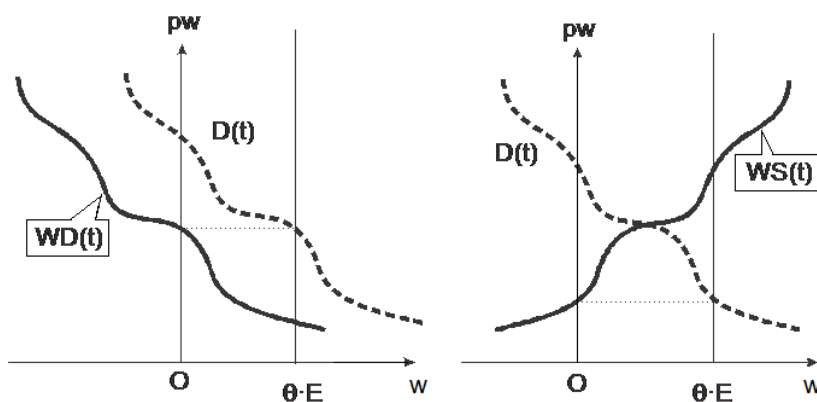


Figure 3.13: illustration of water demand function and water supply function

It is as follows, when a water price is taken along a vertical axis, the amount of water is taken along a horizontal axis and WD function and WS function in a certain time are drawn. That is, WD function is a **water demand function** and WS function is

a **water supply function**. Moreover, a water demand function and a water supply function have a relationship and a water supply function can be derived from a water demand function as shown clearly from (18) and (19).

The water demand function WD and water supply function WS can be changed as follows.

$$\begin{aligned} WD/(\varphi \cdot \alpha \cdot L) &= DL - \theta \cdot E/(\varphi \cdot \alpha \cdot L), \\ WS/(\varphi \cdot \alpha \cdot L) &= \theta \cdot E/(\varphi \cdot \alpha \cdot L) - DL. \end{aligned} \quad \text{-----}(20)$$

This re-expresses water demand and water supply that is actually used for each unit of land.

If the quantity of water securable for one unit of land is set with $\bar{w} = \theta \cdot E/(\varphi \cdot \alpha \cdot L)$ in that case, and actually uses \bar{w} at a certain time since it may consider that $\theta \cdot E/(\varphi \cdot \alpha \cdot L)$ is fixed depending on analysis, the following can be expressed:

$$\begin{aligned} \text{The actually used water demand function per one unit of land} \\ = DL(p - c_1, p_w) - \bar{w}, \end{aligned}$$

$$\begin{aligned} \text{The actually used water supply function per one unit of land} \\ = \bar{w} - DL(p - c_1, p_w). \end{aligned} \quad \text{-----}(21)$$

The function defined as this appearance may also be called a water demand function and a water supply function.

Section 5: Integration of the arguments

As we have now determined the supply curve of water and a demand curve, we will return to the argument of a monetary utility function. This is because the expected price function of water can be more briefly derived by that.

Monetary utility function $u = u(w, M)$ of a certain irrigation farm is considered. This means it can gain net earnings (i.e. money income before deducting water expense), if water: w is utilised. Furthermore, if stock cash: M increases, it will be assumed that the utility level measured with currency amount increases.

That is, it can be written as

$$u = u(w, M) = NE + M = \{(p - c_1) \cdot f(w) - c_0\} \cdot \alpha \cdot L + M \quad \text{-----}(22)$$

$$du/dw = \{(p - c_1) \cdot f'(w)\} \cdot \alpha \cdot L = MNE(w) \cdot \alpha \cdot L > 0,$$

$$d^2u/dw^2 = f'' \cdot \alpha \cdot L < 0, \quad du/dM = 1 > 0.$$

Then, the marginal rate of substitution ($MRS_{w,M}$) of water for this farmer is set to

$$\begin{aligned} MRS_{w,M} &= \frac{\partial u / \partial w}{\partial u / \partial M} = \frac{\partial u}{\partial w} = \{(p - c_1) \cdot \frac{\partial f}{\partial w}\} \cdot \alpha \cdot L \\ &= MNE(w) \cdot \alpha \cdot L \quad \text{-----}(23) \end{aligned}$$

Therefore,

$$\frac{dMRS_{w,M}}{dw} = \{(p - c_1) \cdot \frac{\partial^2 f}{\partial w^2}\} \cdot \alpha \cdot L = MNE' \cdot \alpha \cdot L < 0$$

is obtained. Here, f is a production function of Section 2 (or [14]) and MNE is the same as marginal net earnings of water in equation (16).

From (23), the buyer's marginal rate of substitution (MRS) curve per unit of land is equal to the MNE curve and is a downward slant to the right. Moreover, as (12) and (13) showed, (23) shows that the expected price of one unit of water, i.e. the expected water price, is equal to MNE . Moreover, this means that a seller's MRS curve is a simultaneous upward slant to the right (see [21]).

Therefore, to assess the greatest amount that may be paid for the acquisition of water by an irrigation farmer, it is natural to consider MNE when an irrigation farm is buying water. In other words, the expected cost to an irrigation farmer can be considered to be MNE . That is, it is possible that

$MRS \text{ curve} = MNE \text{ curve} = \text{Water demand curve of irrigation farm} = \text{Expected price curve of irrigation farm} \text{ ----- (24)}$
is realised.

Moreover, it is possible that the water market price is decided by the intersection of the demand curve and a supply curve.

The MNE curve can be considered to be a demand curve when purchasing water. Therefore, the regulating factor in the demand curve of water is as follows:

- If the price p of the products of an irrigation farm rise, an MNE curve will be shifted upwards. Therefore, when the water price p_w is constant, water demand increases.

- If input-goods prices other than those for water rise, since c_1 increases, an MNE curve will be shifted down. Therefore, when the water price p_w is constant, water demand decreases.

- The rise of the water price p_w decreases water demand.

Next, the argument for the seller of water is as follows. If w of water was used, only $\bar{w} - w$ of water will remain among the water secured through water entitlements. The opportunity cost of water when water remains $\bar{w} - w$ is shown by the value when $\bar{w} - w$ is substituted for a MNE curve (i.e. $MNE(\bar{w} - w)$).

Therefore, a seller's supply curve serves as a symmetrical type focusing on the vertical axis of $w = \frac{\bar{w}}{2}$.

We will actually draw a supply curve from the demand curve of water. If certain crops are produced by the injection of water, net earnings, which is not a deductible water expense, will occur. A producer will presuppose that it is 1 and 2 now, and we will write the products of each water injection to be $q1 = f1(w1)$, $q2 = f2(w2)$. If net earnings which do not deduct water expenses is written as $NE1$ and $NE2$, respectively, each net earnings will be set to $NEi = \{(p - c_{1i}) \cdot f_i(w_i) - c_{0i}\} \cdot \alpha_i \cdot L_i$ ($i=1,2$). Therefore, the marginal net earnings of each water injection (MNE)

becomes $MNE_i = \{(p - c_{1i}) \cdot f_i'(w_i)\} \cdot a_i \cdot L_i$ ($i=1,2$). Here, it means that $f_i'(w_i)$ is the marginal productivity of water for each producer.

For example, suppose that *MNEs* of water for both producers have the appearance of Figure 3.14 (it is assumed that producer 1's earning capacity is higher).

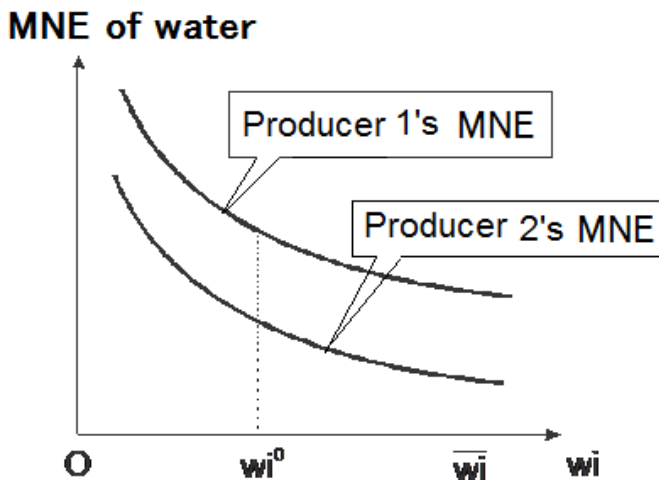


Figure 3.14: MNE curves

Supposing producer 2 uses w_2^0 of water at this time, only $\bar{w}_2 - w_2^0$ of water will remain. And (assuming that the sale of water is possible due to the development of a water market) when $\bar{w}_2 - w_2^0$ of water can be sold, what price level would make a selling point? It would be natural to think of the amount that was probably obtained, supposing $\bar{w}_2 - w_2^0$ of water is

required for production, as an opportunity cost. Then, an opportunity cost in when producer 2 sells only $\bar{w}_2 - w_2^0$ of water will be set to $\{(p - c_{12}) \cdot f_2'(\bar{w}_2 - w_2)\} \cdot \alpha_2 \cdot L_2$. Therefore, $MNE_2(\bar{w}_2 - w_2)$ show the supply curve when producer 2 becomes a seller of water. It will be set to

$$\frac{dMNE_2}{d(\bar{w}_2 - w_2)} = \frac{dMNE_2}{dw_2} \cdot \frac{dw_2}{d(\bar{w}_2 - w_2)} = -\frac{dMNE}{dw_2} > 0, \quad \frac{d^2 MNE_2}{d(\bar{w}_2 - w_2)^2} = \frac{d^2 MNE_2}{dw_2^2} > 0$$

if this is differentiated from $(\bar{w}_2 - w_2)$.

This seller's (producer 2's) supply curve is shown in Figure 3.15. The sale of water by volume $(\bar{w}_2 - w_2)$ is taken along the horizontal axis. This simultaneously becomes the buyer's amount of water purchased. In conclusion, a seller's supply curve serves as an upward slant to the right as shown in Figure 3.15.

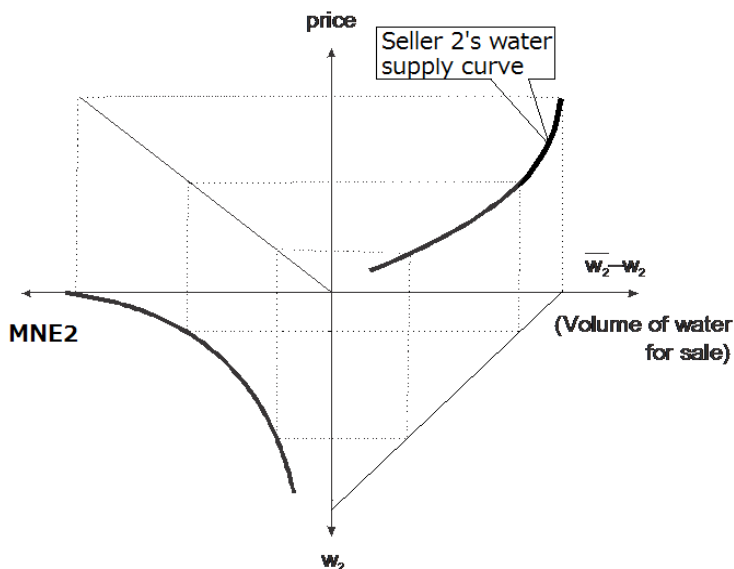


Figure 3.15: derivation of water supply curve

Therefore, it is as follows when the seller's supply curve and a buyer's demand curve are drawn anew and the quantity of water dealt with is drawn for a horizontal axis.

Expected price of water

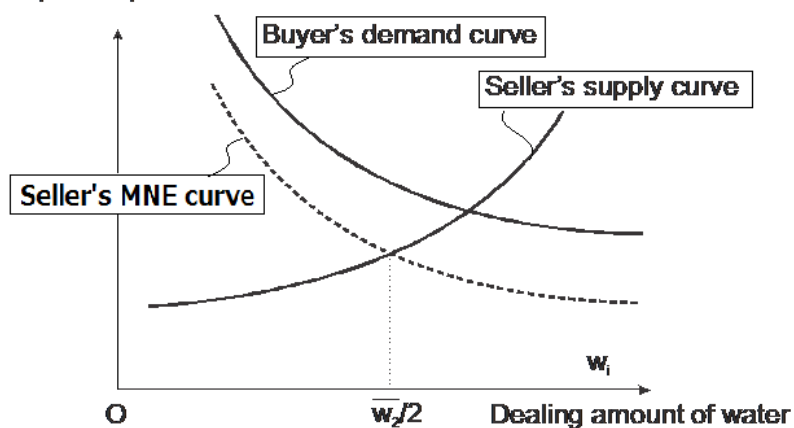


Figure 3.16: interlocking demand curve and supply curve

That is, a seller's supply curve is a curve that reconsiders the marginal net earnings as an opportunity cost, and the form serves as a curve that sets the axis of symmetry as a water amount of supply of $\overline{w}_2/2$ as shown in Figure 3.16.

Thus, both the sellers and buyers of water are producers and it is thought that this feature of the Australian water market, that a seller's supply curve and a buyer's demand curve are related, has given important meaning to the water market:

- It is clear that water markets have an equilibrium point.
- There is a simple method for finding the equilibrium point of a water market.
- Both sides are capable of generating an economic surplus by water dealing. (If the supply curve is flat, the economic surplus for the seller will not occur).
- The demand curve and supply curves of water interlock and move.

In other words, it is possible that because the dealings of irrigation farmers have taken the lead, the secret to the success of the Australian water market lies in having built the typical market described by standard economics textbooks.

Section 6: Money evaluation of the profits of exchange in a water market

The economic merit of water dealings is calculable using the curves for water demand and supply. (In order to work concretely, it is necessary to presume demand and supply curves).

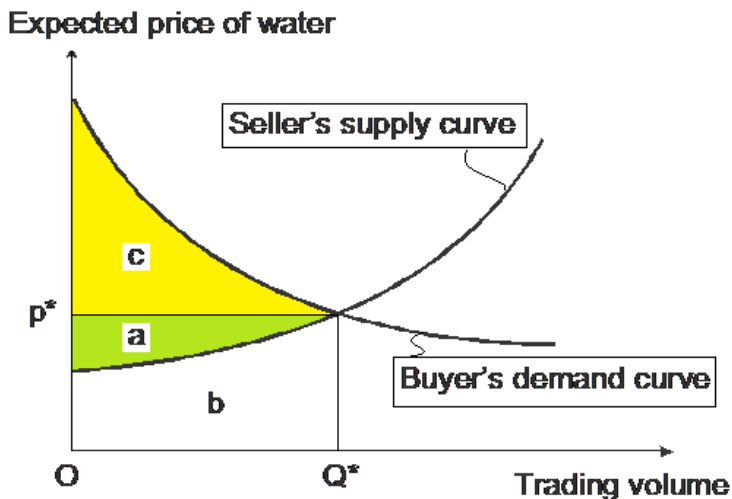


Figure 3.17: concept of economic surplus

For example, if a market price is considered as p^* and equilibrium quantity is considered as Q^* when considering a buyer, the buyer's amount of payment $p^* \cdot Q^*$ is shown by area $a+b$. On the other hand, the amount of money that a buyer may pay is denoted by $a+b+c$. Therefore, it will be said from the buyer's viewpoint that these dealings were measured with currency and the area c was gained. When similarly seen from

the seller's perspective, while acquisition of money of the area b was expected, the currency amount that actually came to hand was area $a+b$. If $a+b$, and the seller evaluated these dealings with currency, it gained after all only a .

Speaking generally, the sharper the slope of a demand curve (i.e. when demand price elasticity is small), the larger the buyer's surplus becomes. On the other side, when a seller has a large surplus, the slope of the supply curve becomes sharp (so that the supply price elasticity is small).

Next, we will illustrate the economic merit of water markets using water demand and supply curves. Two merits exist. One is the **profits expansion effect**, which is acquired in the usual case. Another is the **ratchet effect** which stops loss in the case of a drought.

(A buyer's profit expansion effect)

When there is no water market, the irrigation farmer's demand curve shows the marginal net return of water that can be obtained. Therefore, when the water rights E has guaranteed 100 per cent of water distribution, the expected earnings are shown by the area of $a+b$. However, if a water market can be created and there can be additional purchases of water, it will, for example, enable only EF to carry out the additional purchase of water. As a result, since $c+d$ has only required the expense of d for the purchase of water (although additional profits are

obtained), if a total is carried out this producer can add only c profits. This is the profit expansion effect of a water market.

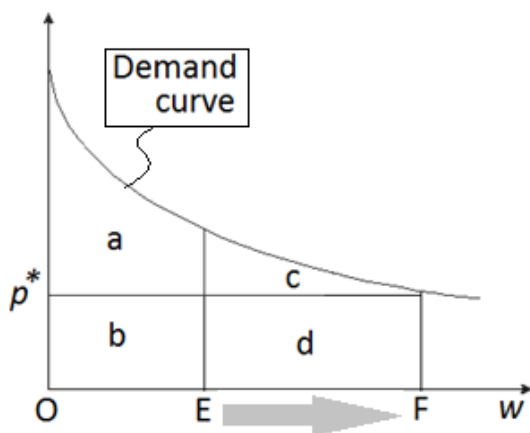


Figure 3.18: a buyer's profits expansion effect

(A buyer's ratchet effect)

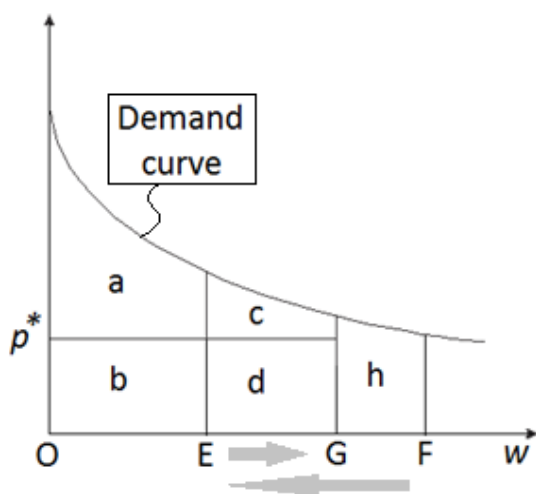


Figure 3.19: a buyer's ratchet effect

In a case where distribution of water rights are guaranteed 100 per cent, we will make the distribution of water into point F. The profit (i.e. net return except ordinary water expense) at that time is $a+b+c+d+h$. However, actual water distribution in a drought presupposes that it was point E . As a result, the loss by drought serves as $c+d+h$. Now, suppose that the additional purchase of water of the point EG was carried out using the water market. Since it is necessary to pay money for the purchase, a net return is set to c . Then, this producer can make the profit of $a+b+c$ in spite of a drought. The loss of $c+d+h$ was able to be stopped at $d+h$ by the existence of a water market. That is, the size of c is the ratchet effect of a water market.

(A seller's profit expansion effect)

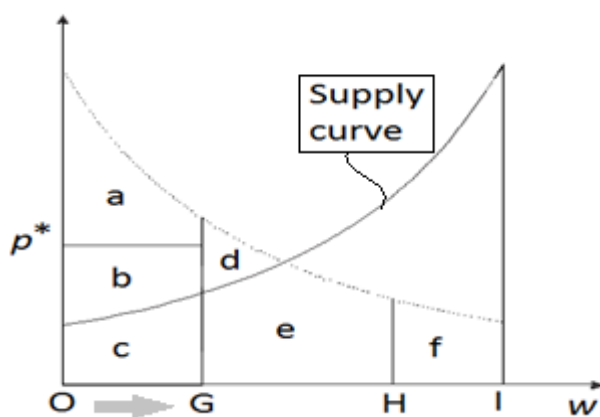


Figure 3.20: a seller's profits expansion effect

When there is no water market and water rights are guaranteed 100 per cent, we presuppose that point I is the distribution of

water. At this time, this farm can get the profits of $a+b+c+d+e+f$. Suppose that a water market is opened and water can now be sold. Then, the farm will consider selling the water for a profit and see that it has realised only OG . Supposing it is decided that the sales total of water will be p^* , $b+c$ will serve as the area of the circulation income of water. But considering the opportunity cost c , the increase in profit made possible by the existence of a water market serves as the area of b . This is the profit expansion effect.

(A seller's ratchet effect)

Suppose that drought decreased the water distribution amount from the point J to the point I . The way things stand, only the loss of area e arises. Then, consider selling water of HI in a water market. Supposing water is sold only at a price of p^* in a water market, a total income will serve as the area $a+b+c+d+f+g$. But if an opportunity cost is taken into consideration, the total net return will serve as $a+b+c+f$. That is, when there was no water market, the total net return was $a+b+c+d$, but since the water market existed, the loss was able to be limited to area $f-d$. That is, $f-d$ is a ratchet effect.

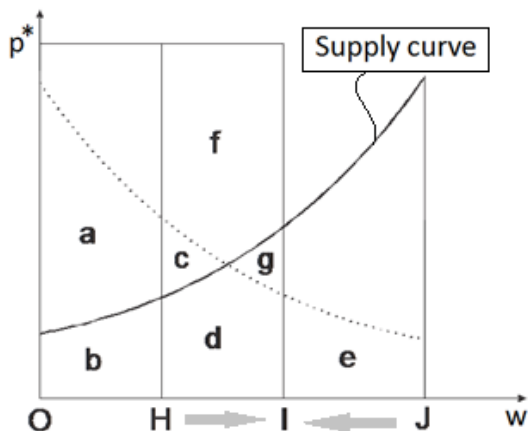


Figure 3.21: a seller's ratchet effect

Section 7: The Coase theorem and emission rights trading

The Coase theorem also sets up private ownership for 'bads', so called because they not only include the usual 'goods' but a pollution factor, and when the party concerned trades in it spontaneously, it can be said to show that it can shift to a better state. Therefore, it is generally said that the possibility of the market restricted to useful goods will be expanded to the domain of environmental problems, and will open up the possibility of a market solution to an environmental problem. We have adapted the model of Robson (2012) for a water market problem and here introduce the essence.

The two parties concerned are set to 1 and 2. They can be the company that generates pollution, residents affected by damage,

an upstream local delegate (state government) or a downstream local delegate (state government), etc.

The company concerned uses water for production and, since it is easy, all the water is discharged into a river. The local residents who use the water will assume that the water is suffering damage from upstream drainage.

The monetary utility function of the company will be written as $u^F = u^F(w, M^f) = u^F(w) + M^f$. Here, w is supplied for production and is the quantity of water discharged. M^f is the stock cash the company holds. The more production (i.e. injections of w) and stock cash there is, the more it is assumed that the utility level of the company increases. But it is also assumed that the marginal utility of water decreases gradually. Moreover, as is easily confirmed, monetary marginal utility is 1.

Next, the residents' monetary utility function u^R is written as $u^R = u^R(\bar{w} - w, M^r) = u^R(\bar{w} - w) + M^r$. Here, \bar{w} is the maximum water that can be used by the company and is extrinsically decided by the maximum quantity of production or by the size of the water rights the company holds. Therefore, $\bar{w} - w$ expresses the intact water for the company. Namely, the more the intact water of the company increases, for the residents who worry about pollution drainage, the water becomes purer and the more the residents' utility level increases. The residents' stock money M^r has the same meaning as that for the company.

Since the marginal rate of substitution of water and company's money becomes $MRS_{w,MF}^1 = -\frac{dMF}{dw} = \frac{\partial uF/\partial w}{\partial uF/\partial MF} =$

$\frac{\partial uF/\partial w}{\partial uF/\partial MF}$, $\frac{\partial uF}{\partial w}$ expresses the money evaluation of making the company's drainage increase by one unit. By assumption, the marginal utility of water is positive and it decreases gradually. Therefore, the company's money evaluation of drainage reduction increases with the reduction of water. (That is, in order to reduce more drainage, more currency is needed).

On the other hand, since the marginal rate of substitution of water and residents' money becomes $MRS_{\bar{w}-w,MR}^2 = -\frac{dMR}{d\bar{w}} = \frac{\partial uR/\partial(\bar{w}-w)}{\partial uR/\partial MR} = \frac{\partial uR}{\partial(\bar{w}-w)}$, $\frac{\partial uR}{\partial(\bar{w}-w)}$ expresses the money evaluation to the residents' side of reducing one unit of drainage.

By assumption, the marginal utility to residents' drainage reduction (i.e. the increase in intact water) is positive and decreases gradually. Therefore, the money evaluation to residents' drainage reduction decreases with the reduction of water.

In order to argue intelligibly, we will use the following numerical examples. A company will presuppose that \$1000 is required for reducing one unit of drainage. Furthermore, suppose that \$2000 is required for reducing one more unit, and so on. On the other hand, if residents can reduce one unit of

drainage, they think that \$10,000 may be paid to the company. Furthermore, if one more unit of drainage is reduced, it will be assumed that it is thought that \$8000 may be paid, and so on. Table 3.1 illustrates this.

Amount of drainage reduction	Marginal valuation of a company	Accumulated amount	Marginal valuation of residents	Accumulated amount
1	1000	1000	10000	10000
2	2000	3000	8000	18000
3	3000	6000	6000	24000
4	4000	10000	4000	28000
5	5000	15000	3000	31000
6	6000	21000	1600	32600
7	7000	28000	800	33400
8	8000	36000	400	33800
9	9000	45000	200	34000
10	10000	55000	100	34100

Table 3.1: the negotiation table of a company and residents

When the reduction is four units, the company's marginal money evaluation and the residents' marginal money evaluation are in agreement and both marginal rates of substitution are equal. Residents pay $4 \times \$4000 = \$16,000$ for the company's four units' reduction and the company receives \$16,000. By these dealings, since the company obtained \$16,000 for the estimated

loss of \$10,000 in a cutback in production, it gets a profit of \$6000. On the other hand, since the \$28,000 amount of pollution damage was avoided by the payment of \$16,000, residents profit by \$12,000. That is, the company attained an improvement in the continuation of production, and further profit, and residents have realised the preservation of the environment at a relatively cheap expense. By these dealings, the residents and the company have also clearly improved their utility level over the former state (i.e. they have achieved Pareto optimality).

If a company employs many residents and contributes to the community in ways other than pollution, such a solution deserves attention. However, when Robson considers the problem of the transaction cost – and a large amount of transaction cost exists on the resident and company side – it proves that the Coase theorem is not realised. Moreover, there is the problem of whether the residents can make the big ticket payment that is required to make it worthwhile for the company. Furthermore, there is also the long-term problem of whether the residents can continue paying over the long period of time during which the company continues.

In that case, the government may intervene appropriately and reduce transaction costs, or a subsidy may be provided to ease the residents' burden, or a subsidy may be used for the company's investment in environmental improvement, or it

could end up in court. However, if the legal solution leads to the closing of the company, the residents' original demand will not be met because many jobs will be lost from the community. If such an actual profit-interdependent situation is taken into consideration, it can be said that the Coase theorem has a big meaning in how the introduction of emission rights trading, etc. has opened the way for a market solution to an environmental problem.

Section 8: Summary

The main conclusions that can be drawn from this chapter are as follows:

- If a gap in labour productivity or resource productivity (marginal productivity of resources) exists among exchange parties, a comparative advantage of production of goods will occur. In that case, spontaneous exchange brings both sides material gain (Pareto optimal state).
- In the market economy that mediates the exchange of money, spontaneous exchange of goods and money brings both sides material gain (Pareto optimal state).
- In the market economy, a buyer's marginal rate of substitution of goods and money decreases as the trading volume of goods increases.

- In the market economy, a buyer's marginal rate of substitution of water and money is equal to the expected price of water. It decreases as the trading volume of water increases.
- The demand curve of water serves as a downward slant to the right and the supply curve of water serves as an upward slant to the right.
- The reason the demand curve of water serves as a downward slant to the right is that the marginal net earnings decreases with increased injections of water.
- The reason the supply curve of water serves as an upward slant to the right is that the opportunity cost (i.e. marginal net earnings) lost by parting with water increases.
- Water demand and water supply are prescribed by the same factors when the market participant is an irrigation farmer. They are product price, variable cost, the marginal productivity of water, the capacity factor of land, land area, the amount of water entitlements, the allocation rate, the type of crops, the character of annual water demand distribution and the price of water.
- The introduction of a water market can give sellers and buyers both the profit expansion effect and the ratchet effect.

- Analysis of water markets is applicable not only to useful goods (goods) but also to the analysis of environmental pollution goods (bads).

Chapter 4

Logical Analysis of a Water Market

Having established the foundation for economic analysis of water markets in the preceding chapter, this chapter applies the results of that chapter to some important problems, with some additional analysis.

The issues we will deal with are the influence of drought and the problems of externalities, transaction costs and monopolies, and the meaning of a private property system in relation to water dealings.

Section 1: Influence of drought

4.1.1 In the case of drought

Anticipation of a drought is set to θ ($0 \leq \theta \leq 1$). Even if water rights E are held, the actually distributed amount of water $\theta \cdot E$ decreases in the case of drought. That is, anticipation of a drought will reduce θ ($\theta_0 > \theta_1$). Therefore, in Figure 4.1, the water supply function WS is shifted to the left-hand side and the water demand function WD is shifted to the right-hand side.

In the case of a demand curve, the size of the shift is set to

$$\Delta WD = WD_1 - WD_0 = (\theta_0 - \theta_1) \cdot E_d > 0.$$

On the other hand, in the case of a supply curve, the size of the shift is set to

$$\Delta WS = WS1 - WS0 = - (\theta_0 - \theta_1) \cdot E_s < 0.$$

When the amount of water rights for seller and buyer are the same (i.e. when it is $E_d = E_s$), the size of a shift of a demand curve and a supply curve becomes the same. Therefore, there is an equilibrium price rise and no change in trading volume. (The equilibrium point changes to E1 from E0. Refer to Figure 4.1).

When it is assumed that the amount E_d of water rights that buyers hold is larger than the amount E_s of water rights that a seller holds, the direction of the shift of the demand curve becomes large and, as a result, water price has a high likelihood of soaring and increasing from that which existed before the change of trading volume. That is, drought activates a water market. (The equilibrium point changes to A from E0. Refer to Figure 4.1).

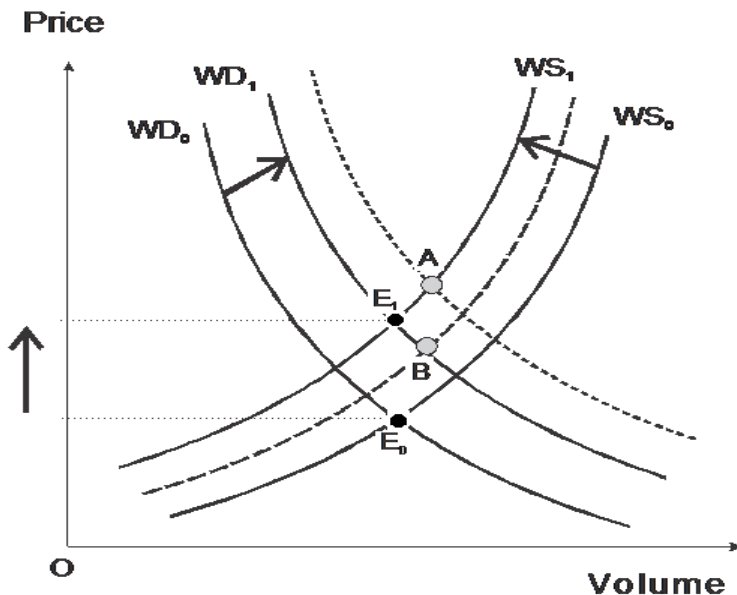


Figure 4.1: influence of θ falling in the case of drought

Furthermore, when the prices (it is necessary to take into consideration international crop price changes and, in the case of international merchandise, exchange rates) p of crops rise with a drought ($p_1 > p_0$), since it is thought that the water demand function DL per one unit of lands shifts to the right-hand side, the WD curve is shifted to the right-hand side and the WS function is shifted to the left-hand side.

$$\text{Shift of a demand curve: } \Delta WD = WD_1 - WD_0$$

$$= D(p_1) - D(p_0) > 0,$$

$$\text{Shift of a supply curve: } \Delta WS = WS_1 - WS_0$$

$$= - (D(p_1) - D(p_0)) < 0.$$

As a result, the water price rises further and the change of trading volume is unknown. However, when the seller and the buyer produce other goods and the rise of crop prices does not affect the seller's supply curve, the possibility is high that it will be set to $\Delta WS = 0$ and the trading volume will also increase (as in the case of point A in Figure 4.1).

Next, if a buyer's rate of land use does not change ($\alpha_0 = \alpha_1$) but a seller's rate α of land use decreases with a drought ($\alpha_0 > \alpha_1$), since a seller's DL function shifts to the left, the water supply curve will be shifted to the right. Therefore, the rise in water prices is eased in this case and there is the possibility of increasing trading volume (as in the case of point B in Figure 4.1).

Shift of a demand curve: $\Delta WD = WD1 - WD0$

$$= (\alpha_1 - \alpha_0) \cdot \varphi \cdot DL \cdot L = 0,$$

Shift of a supply curve: $\Delta WS = WS1 - WS0$

$$= - (\alpha_1 - \alpha_0) \cdot \varphi \cdot DL \cdot L > 0.$$

4.1.2 In the case of an extreme drought

With an extreme drought, all the sellers define it as a situation where it becomes impossible to supply water. In this case, the water price becomes equal to the price (p_{max}) of greatest marginal net earnings and the water market is considered to

have stopped functioning. This is because nobody can purchase the water if the water price exceeds the price at which the farmer can make the greatest marginal net earnings (refer to Figure 4.2).

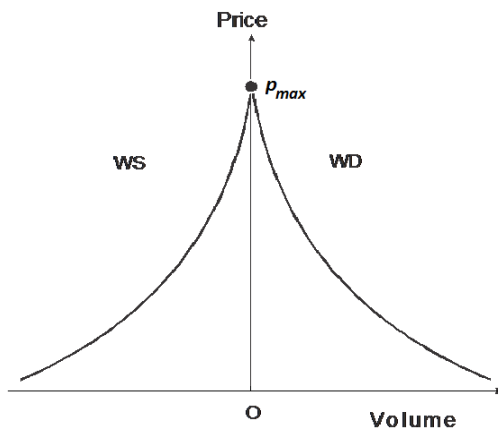


Figure 4.2: water market in the case of extreme drought

Section 2: Externality

Water markets cause various externalities. For example:

- Water pollution due to the increase in agricultural run-off
- Rising groundwater and salt water damage generated by superfluous water
- Deterioration of the ecosystem and decrease in the recreational and scenic value at the water's source.

What are the effects of the problem of externality in a water market? Two aspects of this problem will be considered: one is the problem of water pollution and the other is the problem of environmental degradation.

4.2.1 Water pollution

First, when there are no drainage regulations and there is also no fine, for example for excess drainage, irrigation farmers will not change their actions but continue to perform an economic activity like before.

As a result, conflicts of interest, such as between upstream and downstream irrigation farms and residents will increase, and will become a legal or political problem. Therefore, in a democratic society, sooner or later, the drainage and regulation standards will be amended and fines will be imposed. Next, we consider fines being imposed.

4.2.1.1 Package fines

If the size of the fine is written as PE when the fine is paid by package (for example, in cases where a farmer loses a trial and damages are paid to a victim), the utility function of an irrigation farm will serve as $u = u(w, M - PE) = u(w) + M - PE$. Therefore, although the utility level of an irrigation farm is measured with money, only PE decreases and monetary wealth

decreases – there is no change in the amount of injections of water. That is, a package fine system does not affect the production activity of an irrigation farmer. Because the irrigation farmer is independent and can install equipment for effluent treatment, package fines are avoided in the long run. Also, a farmer can discontinue business, depending on the size of his capital investment.

Naturally, if a discontinuation of business occurs the decline in water quality will be stopped, but there is also the great possibility that income and employment will be lost from the area concerned and population will be lost. In this case, government bail-out packages for capital investment of irrigation farmers will be needed.

4.2.1.2 Meter-rate based surcharges

The next is a case where a surcharge is imposed according to a discharge.

If β is a drainage rate and the amount of water used is w , a discharge will serve as $\beta \cdot w$. Furthermore, if it assumes that drainage has a difference in concentration and contents, and if it is assumed that there is the exchange rate ξ according to each, the size of the impact to the environment at the time of seeing w as an environmental pollution factor will serve as $\xi \cdot \beta \cdot w$. Therefore, it would be rational to impose a surcharge according

to this. If the size of a fine is set to t to one unit of drainage, now, the profits per land unit of an irrigation farmer π will be set to

$$\pi = (p - cI) \cdot f(w) - pw \cdot w - t \cdot \xi \cdot \beta \cdot w - c0.$$

Since the maximum point turns into the point of filling

$$(p - cI) \cdot f'(w) = pw + t \cdot \xi \cdot \beta, \text{ introduction of } t \text{ clearly}$$

affects the water demand of irrigation farmhouses. If other situations are not changed, the water amount demanded will decrease with the increase of t (therefore, the quantity of production would also decrease) and it will shift the DL function (i.e. $w = DL(p - cI, pw + t \cdot \xi \cdot \beta)$) to the left-hand side (e.g. the water demand function being shifted below in Figure 4.3).

The water demand of irrigation farms also comes to be affected by the exchange rate ξ and the drainage rate β , besides the surcharge amount t .

Since it is thought that the DL function is shifted to the left by t , the WD function is also shifted to the left and the WS function is considered as a shift to the right. Therefore, supply increases, and since demand decreases, the water price falls (refer to Figure 4.3).

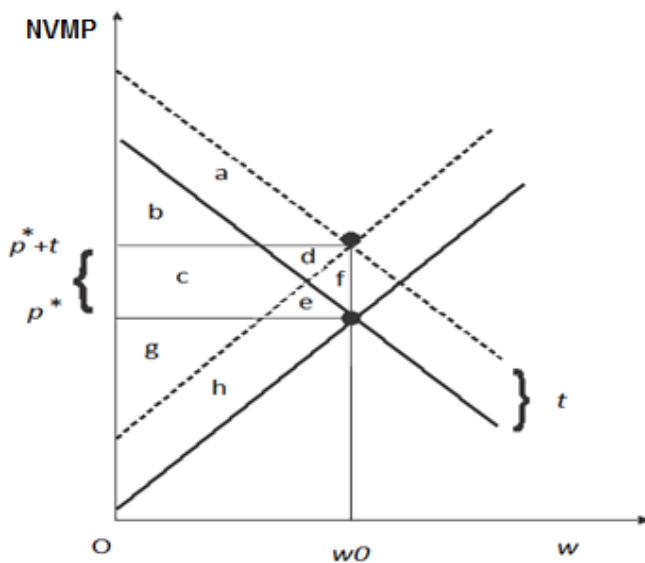


Figure 4.3: effect of a meter-rate based surcharge
 (Note: it is assumed for drawing that it is $\xi \cdot \beta = 1$)

The financial state of an irrigation farmer is as follows. A former water price is set to p^*+t . The net return of a buyer's irrigation farm was $a+b$ before. A drainage surcharge is introduced and a demand curve and a supply curve are shifted below, respectively, and presuppose that the water price would be p^* . As the seller does not need to pay a drainage surcharge, the supply curve should not change. But if a water demand curve shifts down (left), because the Australian water demand and water supply are interlocking, they will also make the water supply curve lower (right) with a shift. Supposing water demand

seldom changes by $w0$, a buyer's net return will serve as $b+c+e-(c+d+e+f)=b-d-f$. If $b=d+f$, a net return will serve as zero.

On the other hand, the seller earned only $g+c+d$ net return before. In a new equilibrium point, a net return serves as $g+h$, and since $w0$ water does not need to be drained, the drainage surcharge does not apply. Therefore, a seller's net return has a high possibility of increasing. This is because it becomes unnecessary for a seller to pay a surcharge by selling water.

On the other hand, in conjunction with the demand curve, the supply shifts down. As a result, the net return (seller surplus) by selling increases. Thus, the introduction of a drainage surcharge does not cause a big reduction in the amount of the water used ($w0$).

The reason environmental regulation has only a neutral effect compared to a surcharge is related to the special feature of Australia in that the water market consists of the homogeneous producer, buyer and seller. A drainage surcharge decreases the income of a buyer's farm but on the other hand makes the income of a seller's farm increase. Moreover, the surcharge income of $t \cdot w0$ increases the government's funds.

Supposing neither the package fine system nor the meter-rate surcharge system achieves sufficient effect, it is necessary to consider another regulation means. This examination is considered simultaneously with the problem of environmental degradation.

4.2.2 Environmental degradation

Long-term movement of a lot of water by a water market clearly has a substantial effect on the environment. It has an influence not only on humans but on all living things.

Now we will consider communities A and B and assume each community has a fixed number of irrigation farmers.

Community A carries out the net export of the water and community B carries out the net import of the water. Each area has water rights and enables maximum use of the water of \bar{w}_i ($i = A, B$). For simplicity's sake it is assumed as $\bar{w}_A = \bar{w}_B = \bar{w}$. If the amount of water used in each actual area is made into w_i ($i = A, B$), $\bar{w}_A - w_A = \bar{w} - w_A$ expresses the net export amount of community A, and $w_B - \bar{w}_B = w_B - \bar{w}$ expresses the net import amount of community B. The movement of a lot of water will presuppose an environmental cost of EC_i ($i = A, B$) is generated. When losing water, and when receiving water superfluously, it is necessary to divide and consider the environmental cost. However, in order to clarify a point of argument, it is assumed that each cost is symmetrical. That is, $EC_A(\bar{w} - w_A) = EC_B(w_B - \bar{w})$ (refer to Figure 4.4).

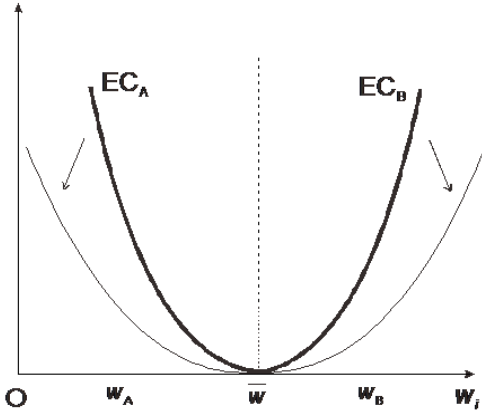


Figure 4.4: environmental cost curve of the net export area and the net import area

The community utility function for each community will presuppose that environmental expenses are minimised as much as possible and also the level of production Q_i is raised. That is, it can be written as $u_i = u_i(Q_i, EC_i(|\bar{w} - w_i|))$ ($i=A, B$). However, this level of production is connected with the use of water. Therefore, the problem that the community i ($i=A, B$) should solve becomes:

$$u_i = u_i(Q_i, EC_i(|\bar{w} - w_i|))$$

$$= p_i \cdot f_i(w_i) - p_w \cdot w_i - c_i - EC_i(|\bar{w} - w_i|) \rightarrow \text{Maximise}$$

$$\text{Subject to: } Q_i = f_i(w_i), EC_i = EC_i(|\bar{w} - w_i|), i=A, B.$$

Here, p_i ($i=A, B$) is the price of the product that each area produces and p_w is the price of water. As for p_w , because the water market is competitive, it is assumed to be the same in both areas. Moreover, c_i is a constant expense for each area.

The conditions of utility optimisation for each community are as follows, respectively.

$$NVMP_i - MEC_i$$

$$= \{ p_i \cdot f'_i(w_i) - p_w \} - EC'_i(\bar{w} - w_i) = 0, i = A, B.$$

That is, the net value of marginal productivity (NVMP) for each community and the marginal environmental cost (MEC) are weighed on a scale and it is necessary to manage the usage level of water so that these differences may become zero. This situation is shown in Figure 4.5.

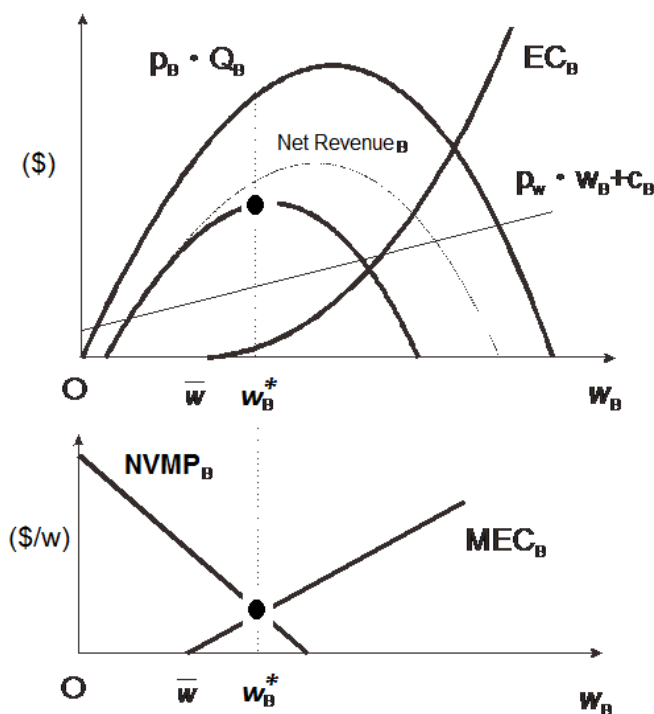


Figure 4.5: determination of community B's optimal water usage

Since in the case of Figure 4.5 the optimal solution w_B^* is over the limit (\bar{w}) of the area, the net import of water ($w_B^* - \bar{w}$) is needed.

If we assume the marginal profitability of community A is lower than B and, as shown in Figure 4.6, if the net import and net export amount of both areas are assumed to be equal, the usage amount of water for each area, the net export amount, and the net import amount will be decided.

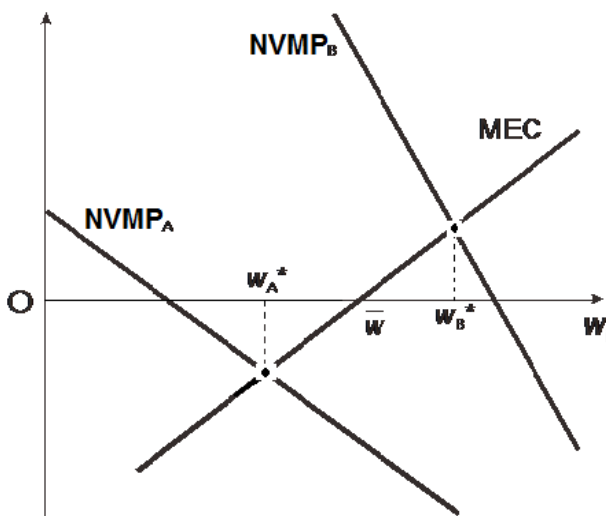


Figure 4.6: determination of the net import and net export amounts

Example: It is considered that the production function of community A $= 31 \cdot w \cdot (14 - w)$, and the production function of community B $= 33 \cdot w \cdot (25 - w)$, and the price of

each area's products is set to $p_A=5$, $p_B=10$ respectively. The water cost is common in each area and sets $p_w \cdot w + c = 10 \cdot w + 5$, and the environmental cost EC is set to $EC = 80 \cdot (w - 10)^2$. The retained water rights are referred to as $\bar{w}=10$ for both areas. The amount of area A's water use, at this time, will be set to $w_A^*=8$ and the amount of area B's water use is set to $w_B^*=12$. Therefore, the net export amount of area A and the net import amount of area B are set to 2 (end of example).

Of course, when this optimal solution is attained by $[0, \bar{w}]$ in the threshold value of the area's water, and supposing there is no export or import of water in the area, there is no particular environmental problem. Moreover, when the optimal solution is in $[\bar{w} - \epsilon, \bar{w} + \epsilon]$ ($\epsilon > 0$) near the threshold value, an environmental problem also does not arise.

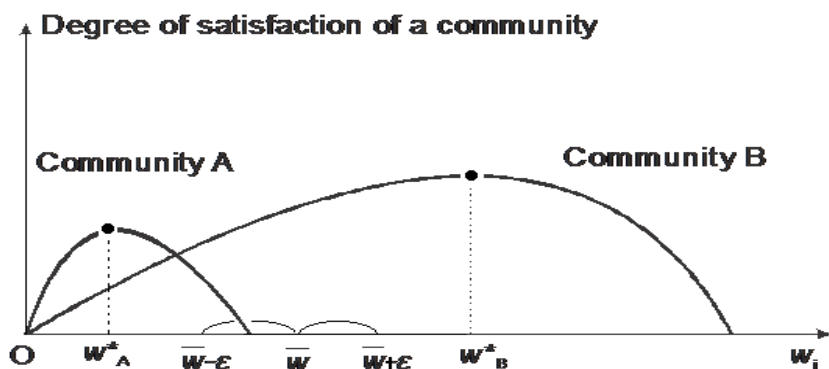


Figure 4.7: the case in which the net import and net export amounts exceed the environmental limit

However, as shown in Figure 4.7, when the net import and net export amounts exceed such a limit, measures are needed. In that case, a regulation forbidding water importation would mean the opportunity for a big economic return is missed. Then, one of the measures considered would be the introduction of a water trading surcharge. That is, rather than forbidding importation, when the net importation of water exceeds a fixed limit, a meter rate based trading surcharge is imposed on those who are going to do the importing.

Then, the marginal returns of community B fall to $p_B \cdot f'_B - p_W - t$ from $p_B \cdot f'_B - p_W$. Here, t is the rate of a trading surcharge in the case of net importation exceeding a fixed level. Then, because the equilibrium point of community B approaches \bar{w} , the negative influence to the environment is inhibited. (We will consider the general influence of the introduction of a trading surcharge in the following section). On the other side, if these trading tax revenues are used for the improvement of the marginal productivity of community A, the equilibrium point of community A will also approach \bar{w} (since the marginal returns line of community A is shifted up). In this way, the mutual demands of environmental preservation and water supplies for people will be satisfied and the gap between communities will also be reduced. (Chapter 10 explains an actual example of a zoning surcharge).

There is another measure called reduction of environmental cost.

If environmental cost is reduced, the marginal environmental cost curve in Figure 4.6 will rotate to the right, focusing on point $(\bar{w}, 0)$. This activates economic activity and increases net export and net import amounts. However, since the environment was strengthened by the reduction of environmental cost so to speak, the degree of incidence to the environment will fall. People's welfare level will increase as a result.

It would probably be effective to introduce the trading surcharge described above as a preventive measure when the negative influence on the environment cannot be fully predicted.

The following can be considered to be environment-strengthening measures for concretely reducing environmental cost:

- (1) Purchase or sell off water to counter the direction of net export or net import
- (2) Reduce the cost of the environmental damage caused by the net export of one unit of water using another regulation means.

The former is currently used as a way of tackling the Australian environment's water problem. Chapter 11 explains this in detail. Moreover, Chapter 10 explains how salt credits are applied to

compensate for the damage generated by salt water, using the techniques of emission rights trading.

Regarding the latter point, the movement of water creates stress to the environment. In Australia, the CMA (Catchment Management Authority) enacts measures to counter this. Chapter 9 and Chapter 11 examine the activity of the CMA.

With respect to the reduction of environmental cost, the reduction and prevention of the damage before it happens generally incur a large expense, and there is the problem of how it should be paid. Returning a producer's profits by implementing a drainage surcharge, implementing a residents' tax, and national park entry fees can all be considered. However, in the Australian water market irrigation farmers can be sellers and also buyers, so a drainage surcharge is not as effective as shown in 4.2.1.1 and 4.2.1.2. Imposing a surcharge on the export (or import) of water exceeding a fixed limit would probably be effective enough. Furthermore, it is useful from a view of the effect of reserving money that can be devoted to the environment. In this case, an additional surcharge is not imposed on the use of water, but on the movement of water to a specific area.

There could also be a problem resulting from the improvement of an area's industrial structure when carrying out net importation of water to a target. The area that buys water is an area of high marginal profitability for industry and the area

that sells water is considered to be an area of low marginal profitability for industry. In 4.2.2, for simplicity's sake, assume that the productivity and environmental expense of the land of both areas are equal. One of the policies the area where marginal profitability of industry is low should adopt would be to create industry (or products) that seldom need water, or to increase the competitive power of industry. Such a natural reform (industrial revitalisation package) is also needed with the above-mentioned environmental measure. And the government that manages a range wider than a single community needs to aim at adjusting the interest of both areas as a way of balancing the uneven development between environment, economy and the area.

Section 3: Transaction costs

Transaction costs are the expenses other than the original expense are incurred by market participants because the water markets are not installed perfectly.

For example:

- Expense of collecting and understanding information about the structure and rules of the water market,
- Expense (the time cost, etc., are included) concerning the applications for dealings, expense and time until a negotiating partner is found,

- Expense and time until pricing is agreed with a negotiating partner,
- Expense and time when negotiations do not materialise,
- Expense and time until use of water is attained when actual negotiations materialise,
- Expense and time spent on accounting treatment when dealings are successful etc.

When such transaction costs exist, what influence does it have on participants in a water market?

Transaction costs are assumed to be proportional to trading volume and ts is set for the seller and td for the buyer for transaction costs per unit of water per land unit. A buyer's transaction costs, td , affect an irrigation farmer's action.

If a NVMP (net value of marginal productivity, or marginal net earnings) curve is written to be NVMP (w) per a buyer's land unit, a new equilibrium point will change from NVMP(w) = pw to NVMP(w) = $pw + td$. (The water demand curve is the same as an NVMP curve, as discussed in Chapter 3). If this is transformed with NVMP(w) - td = pw , a new equilibrium point will turn into the point where expense, excluding the transaction costs td from the marginal net earnings, and the water price become equal (refer to Figure 4.8).

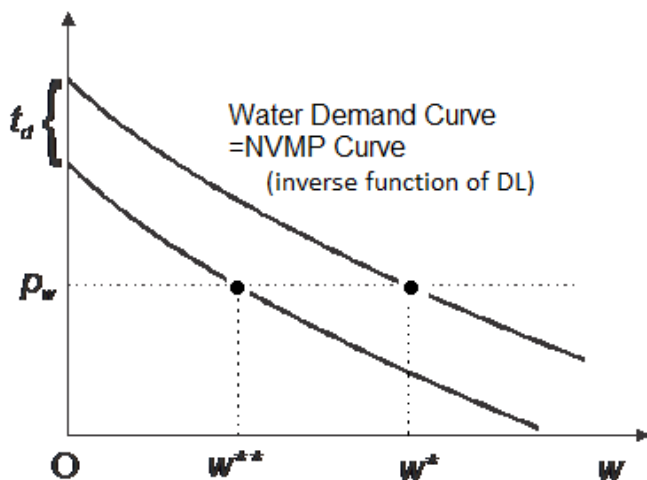


Figure 4.8: influence of transaction costs proportional to trading volume

Therefore, a new NVMP curve (i.e. inverse function of DL. Refer to formula (16), Chapter 3, for DL function) becomes that to which td shifted the former NVMP curve down per land unit. Only $(w^* - w^{**}) \cdot \varphi \cdot \alpha \cdot L$ shifts the water demand curve WD to the left, therefore this shifts the water supply curve WS to the right.

Next, a seller's case is considered.

A seller is subject to two influences.

As the lower (left) shift of a water demand curve (i.e. inverse function of DL) changes water supply curve of per land unit to

$WS = \theta \cdot E - \varphi \cdot DL^* \cdot \alpha \cdot L$, a water supply curve is shifted down (right). (Be careful of the relation of $DL^* = DL^*$ $(p - cI, pw + td) < DL(p - cI, pw)$).

On the other hand, because transaction costs are also needed for supply behaviour, the expense of ts is required according to the amount of water supplied. This shifts the inverse function of DL (namely, the usual demand function) up (to the left-hand side) only td . Now, if we assume that $ts = td = t$, both effects will become equal and the supply curve WS will not move. On the other hand, the demand curve WD shifts $(w^* - w^{**}) \cdot \varphi \cdot \alpha \cdot L$ to the left.

After all, the situation of a seller and a buyer is as drawn in Figure 4.9. (The drawing is shown as per one unit of land. The actual surplus needs to be multiplied by $\varphi \cdot \alpha \cdot L$).

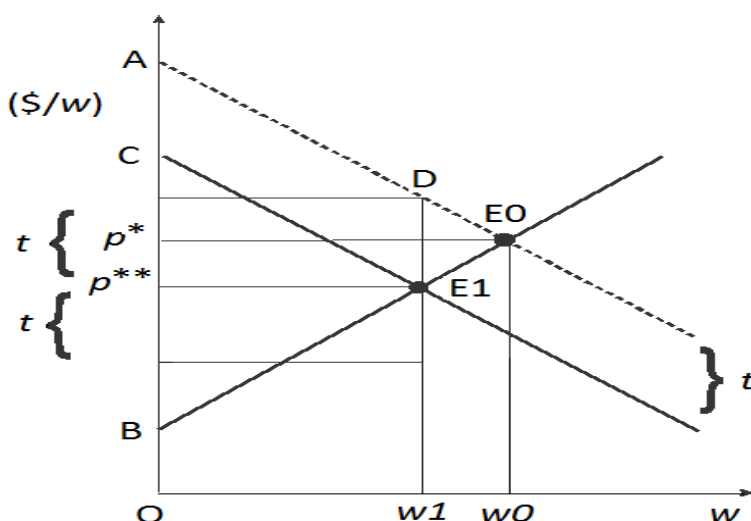


Figure 4.9: influence of transaction costs

That is, a new equilibrium point is set to $E1$ and the price falls only $t/2$ from before. Moreover, the equilibrium quantity decreases. Although it was $ABE0$ at first with the surplus, in a new equilibrium point a buyer surplus serves as a size that subtracted $t \cdot w1$ from triangle $Cp^{**}E1$, and a seller surplus serves as a size that subtracted $t \cdot w1$ from triangle $Bp^{**}E1$. The transaction costs become $2 t \cdot w1$ and this portion disappears. Moreover, the surplus of the portion of the triangle $E0E1D$ by reduction in trading volume also disappears.

Transaction costs have a considerable influence. When they are large, the price and dealings levels fall sharply, net earnings may become zero and the formation of water dealings themselves may be threatened. Such a thing can pose a serious problem in connection with the *raison d'être* of a water market. Therefore, in order for a water market to be successful, transaction costs should be reduced as much as possible. Although water dealings using the internet have become common in Australia, such use still needs to be fully evaluated from the standpoint of the reduction of transaction costs.

(Influence of charges for dealings)

Next, the consequence of having introduced charges for dealings (tax) is analysed.

The charge for dealings is an expense a water market participant in pays according to trading volume and also serves as an income for the market's administrators.

Moreover, this charge for dealings can also be interpreted as a Pigovian tax when environmental regulations and other factors are introduced.

Now, a seller and a buyer presuppose that the charge for dealings of t is similarly collected to dealings of one unit of water.

If t is introduced, only t shifts the conventional demand curve downward. This will be interlocked with the supply curve, and only t will also shift a supply curve down. On the other hand, by introducing the charge for dealings, since charge for dealings is collected by a seller's action, in order to secure an income as usual, the supply curve needs to shift only t up.

A supply curve remains unchanged as a result. Therefore, the same exact analysis as used for dealing costs is applicable. That is, a water price decreases only $t/2$ and the trading volume of water decreases. The surplus of a buyer and a seller decreases. However, the fee equivalent to $2 t^* w^{**}$ will not necessarily have disappeared and serves as an income (the case of a trading tax governmental income) for the administrator (or agent) of a water market.

Therefore, we can point out that it is the same as for transaction costs.

Introduction of a charge for dealings reduces a market equilibrium price and equilibrium quantity and, since the size of the economic surplus of an economic unit is affected, introduction of an excessive charge for dealings of dealings, for example a big charge that extinguishes each participant's economic surplus, will threaten the existence of the water market itself.

Section 4: The problem of monopoly

The term “water baron” is frequently used in articles about the Australian water market. One of the problems of water markets, and one often used as an argument against them, is that of monopoly. We will debate this problem by looking at it in two ways. First, we will look at the possibilities that may arise in such a situation. Second, we will look at what kind of damage occurs and how the general public suffers as a result of monopolies.

4.4.1 The situations monopolies bring about

First, suppose a monopoly appeared. Consider what kind of situation this brings about. We will consider this problem from the perspective of a temporary (allocation) trading market and a permanent (entitlement) trading market.

4.4.1.1 Temporary trading market

With a temporary trading market monopoly, we will consider a subject that purchases or sells off a lot of water in a temporary trading market. First, we will consider the case where a lot of water is purchased. In order to simplify, we will introduce a concrete numerical example. Chapter 5 considers the pricing of water markets in detail, but here such details will be excluded.

Now, we will presuppose the dealings table of the water market at a certain time are as shown in Table 4.1.

Seller's order				Buyer's order				D-S at a buyer's price
No	Offer price	Volume	S	No.	Offer price	Volume	D	
s1	80	60	60	b1	200	100	100	-260
s2	100	80	140	b2	150	140	240	0
s3	150	100	240	b3	100	180	420	280
s4	200	120	360	b4	80	220	640	580
s5	250	140	500	b5				

Table 4.1: the case where a monopoly does not exist

At this time, an equilibrium price is set to 150 and equilibrium quantity is set to 240. In these dealings, there will be cases where the seller (s5) attaches an offer price too high (250) to find a buyer. Now, suppose a monopolist appears with the intention of purchasing water in large quantities. At this time,

for example, an offer price is set to 200 and the volume of orders placed is set to 240. The new dealings table is as follows.

Seller's order				Buyer's order				D-S at a buyer's price
No.	Offer price	Volume	S	No.	Offer price	Volume	D	
s1	80	60	60	b1	200	240	240	-120
s2	100	80	140	b2	150	140	380	140
s3	150	100	240	b3	100	180	560	420
s4	200	120	360	b4	80	220	780	720
s5	250	140	500					

Table 4.2: the case where a monopolist is a buyer

At this time, the equilibrium price will be set to 200 and equilibrium quantity will be set to 240. That is, a baron can buy up all the water (240). If this is repeated, a lot of water can be bought up. However, in order for this monopolist to get profits, there are only two choices.

One is making a profit that exceeds water cost and using the water collected in large quantities. Supposing this can be achieved with effective management and contributes to and improvement in efficiency, which is the original purpose of the introduction of a water market, this would not especially be a problem. Rather, his business modality should be studied and it should be considered as the model for management reform. And since it is a temporary trading market, there is no guarantee his water monopoly would continue in the following fiscal year.

The second choice is selling water at a higher price than at the time of purchase.

Although water can be transferred by a carry-over system, because it cannot exceed 100 per cent of the water rights, even if it carries over water, there is no guarantee whether more profits than this year can be obtained. Therefore, it is necessary to sell water within the same irrigation period that the water was purchased. This would be a bad result.

Now we consider the person who sells off water. He would like to sell the water purchased for 200 dollars at more than that. For example, suppose an order is placed enabling him to sell water bought at 240 for 250 dollars.

Seller's order				Buyer's order				D-S at a buyer's price
No.	Offer price	Volume	S	No.	Offer price	Volume	D	
s1	80	60	60	b1	200	100	100	-260
s2	100	80	140	b2	150	140	240	0
s3	150	100	240	b3	100	180	420	280
s4	200	120	360	b4	80	220	640	580
s5	250	240	600					

Table 4.3: the case where a monopolist is a seller

In this situation, it becomes the case of s5 in Table 4.2 in the selling price is too high and dealings do not materialise. In the case of a buyer, the availability of water for purchase will increase but, conversely, if that buyer becomes a seller, if prices are high there would be an increased possibility that water cannot be sold off. It is difficult for a monopolist to sell water above the purchase price, and difficult to expect speculative profits.

When a “baron” appears as a buyer, it is thought his influence on ordinary participants is as follows (and especially when a drought is severe). First, at a price at which the baron purchased,

the purchase of water by ordinary participants cannot be performed in a water market – purchasers would form an alternative plan, replacing water purchase. For example, in the case of dairy farming, rather than irrigating and growing grass, farmers may maintain milk production by purchasing hay (i.e. substitute goods). Moreover, if crops are changed to varieties with low water needs and the cropping method changes to dry land agriculture (i.e. crops are substituted and an alternative production method is implemented), farmers can to some extent respond to water shortages or a rise in water prices.

The second way market participants could respond to the baron's influence in the market is by reducing (or giving up) production scale and selling their surplus water. If surplus water can be sold at a high price, the loss accompanying production reduction can be stopped.

The third way would be taking on debt, purchasing water at the high price and continuing production. In this case, an important standard of judgments would be how much the sales value of the products rises.

As the above demonstrates, when alternative choices exist, the influence of a water price jump due to a monopoly can be eased. Moreover, a speculative monopoly is not sustainable in the long run.

4.4.1.2 Permanent trading market

Next, the case of a permanent trading market is considered. Here the influence is serious because the transfer is not only of the right to use the water but also ownership of the water itself.

When a monopolist first becomes a buyer in a permanent trading market and purchases water rights, the effects are the same as with a temporary trading market. That is, water rights can be monopolised and, generally, the purchase price will rise when a monopolist presents a higher price. In that case, if a monopolist can continue producing a profit that exceeds purchase expenses, there will be no issue in particular from the viewpoint of economic efficiency.

On the other hand, seen from the perspective of those who part with water rights, these are spontaneous dealings and once negotiation was settled, the appropriate economic surplus should have gone to the person who sold water rights.

However, from the viewpoint of community prosperity, a problem will occur when the monopolistic enterprise's employment absorbency declines in the long run and the area's unemployment rate increases as a result of personnel cost-cutting or technical progress. This is one of the serious evils accompanying monopoly. Taxation must be strengthened to deal with various kinds of bail-out packages (social welfare programs

and local industrial development policies) for small and weak irrigation farms. And there is a need for the strengthening of taxation on monopolistic excess profits and for the regulation of monopoly pricing of products.

But not all monopolies would be the same. The size of the benefits (added value) that were produced by the monopoly and the amount of damage the area suffers when a monopoly exists should be measured; and a monopoly should be accepted only when the former exceeds the latter. Moreover, even if a monopoly exists today, it may be said that the influence of new technical progress and the development of a substitute will affect the future. In such a case, natural industrial selection is performed, so to speak, and the cost required for the area concerned to continue in the future should be considered.

Next, the case where a monopolist tries to attain speculative profits is considered. In that case, it is necessary to sell water rights at a higher price than at the time of purchase. However, it is difficult, for the same reasons as in a temporary trading market, to find such a buyer.

4.4.2 The possibility that monopoly will occur

4.4.2.1 Is the monopolist mentioned above possible?

Suppose that there is a producer with outstanding manufacturing technique and business skills. His marginal returns presuppose

that water rights can be purchased at a high price. He would likely want to extend his enterprise and to own more water rights. In that case, expansion of land is often also included when extending an enterprise. A monopolist of water rights simultaneously becomes a monopolist of land. In order for the land and water monopoly to continue, high profits are required.

One of the means for achieving that is by becoming a monopolistic supplier in the market for one's products and governing a supply price. However, in Australian irrigation agriculture dairy farming, for example, is subject to the influence of international prices, so monopolistic rule over price would be difficult. Fruit-growing and cereal production are also in a state where many small producers are competing and price control is difficult.

If such a situation is taken into consideration, vast amounts of land and water would have to be monopolised and the possibility that the product price could be governed is quite low. Management expenses general to managing vast amounts of farmland would probably increase, as would increasing the economies of scale (average cost curves) to exceed a proper level.

Moreover, in order to ease the influence of drought, even if a monopolist tries to sell water, as the purchase price of water is high, it becomes more difficult to sell at a desirable price. Thus

it can be said it is difficult for a monopolist to use a water market for risk management.

Even if each producer in this situation maintains a scale of a minimum average cost (**minimum optimal scale**), and land and water are monopolised beyond a proper scale, it is thought that the possibility is quite low of a water baron continuing to gain monopolistic high profits.

4.4.2.2 The problem of monopolist other than a producer:

The purchase of water for cities

As previously discussed, the likelihood of a producer monopoly is low as it is difficult to take speculative action. But what about when a monopolist is not a producer? For example, the PC report describes it as follows:

“What is not widely understood is that, with the exception of Sydney, the other capital cities in Australia have opportunities to trade water with the agricultural sector without the need to build any infrastructure. There are further opportunities to create greater inter-connection between rural and urban water systems with minor capital works. Compared to other options such as desalination and recycling, water trading is very attractive from both a financial and environmental perspective (Water Service Association of Australia, sub. 5, p.2 as quoted in PC, 2006, p.75-6).”

As a concrete example, we will use consider the case in which a big city enters a water market to secure a water supply.

The new monopolist is able to purchase water for a high purchase price in a temporary or permanent trading market as he will presuppose that water funds can be raised as required by water rates rises. Water for agricultural use would become water for cities in the long run and, although this depends on the size and frequency of cities' water demand, irrigation agriculture may be subject to big changes. If a pipeline or similar is built and water from a valley, for example, is constantly supplied to the city, the water situation of the farmland in the valley would worsen.

The original purpose of converting water taken from farmland was to create a market where water resources are redistributed and production increases on the whole. Therefore, the market solution will make the problem much more difficult.

In this case various means, including political compromise, should probably be taken to limit the market solution so there would be a surplus in water for agricultural use.

For example, it would be necessary to take the following measures:

- Water rates would gradually increase with the increase in cities' new water demand and water use would gradually be restricted.

- Measures for carrying out temporary water supply in an emergency would be taken.
- Desalination of sea water.
- Water-saving, water-storage and water-recycling technology, would be developed.
- Small dams would be developed, etc.

If seen from such points, the “10 per cent rule” in the state of Victoria, i.e. the rule that restricts water rights ownership ratio of a person without land to 10 per cent of the whole, is meaningful for limiting the water market function mainly to redistribution of a farm’s water (refer to the following for the 10 per cent rule of the State of Victoria.

http://dictionary.nwc.gov.au/water_dictionary/item.cfm?id=667&xref=1, accessed 10 July 2012).

4.4.2.3 The problem of a monopolist other than a producer: the purchase of water by the government for the environment

One more thing to be considered relative to the problem of monopoly, is the situation in which water is purchased from a water market by the government. There is an actual example of this: a plan to carry out a 500gl injection of water for the environment is advancing in six icon sites in the Living Murray

Initiative. Because the reservation of water through the water market is cheaper than the reservation of water by infrastructure construction, the purchase of water for the environment through the water market is advancing (PC, 2006, p.xxxviii).

Big-ticket purchases can be performed by levying a national tax, so government monopoly of water becomes possible for city water.

However, whether water for the environment is securable will be in question in view of the influence on agriculture, because the aim of the government would be the coexistence of agriculture and environment. The spontaneous dealings that led the water market will bring both sides economic earnings when there is a temporary surplus of water for agricultural use.

However, if the purchase of further water rights for the environment in a water market puts the price formation of the water market out of order, or agricultural activity is affected, there will be criticism of this method. This is a problem currently called the **sovereign risk** for irrigation farmers by a change of policy (PC, 2006, p.59). The report states:

“Many grape growers will choose to keep extra water entitlement as a form of risk management [because] there is a fear that governments might be tempted to unilaterally reduce

water entitlements to meet environmental flow targets.”

(Winemaker’s Federation of Australia, sub. 13, p.6 as quoted in PC, 2006, p.60).

Supposing water prices are raised by the purchase of water for the environment by intervention of the government, this will distort the rational price formation of the water market. Such a thing is not industrial selection in a natural form and will distort the allocation of suitable water resources and have a negative influence on the development of Australian irrigation agriculture, since it is based on an artificial cause. Therefore, we have to explore not only a solution by the market method, but a political compromise such as the water rights purchase by a city.

We would like to boil down the problem of reservation of water for the environment and therefore discuss it in detail in Chapter 11.

Section 5: Theoretical analysis of property rights of water

Water rights are the right of private property to water. Therefore, we will start with the definition of ownership.

Ownership is complex, with three rights usually included:

- (1) The right to use property of some kind.
- (2) The right to prevent others from using the property concerned.

- (3) The right to dispose of the property concerned (Robson, p.190).

In addition to the above, we think one more point should be added to the rights of ownership: this is the right to receive neither a fine nor criticism even if the resources are not used appropriately, or the right to not exploit the resources. This point is mentioned later.

When certain resources produce economic profits over a fixed period, this can be regarded as property. As resources may also include resources that do not yield a profit for the time being (for example, mineral resources on the moon or property that is not used), only property that is actually used and has yielded profit is considered.

Now, we face the problem of how to rationally manage this property and efficiently gain economic earnings from using it. An important point that needs to be considered is not only short-term but also long-term efficiency. How should short-term use be restricted in order to maintain the long-term efficient use of fixed property? We would like to examine the advantages and disadvantages of cases where property is managed as a public good, where it is managed as common property, and where private property rights are set up and a market is used.

In addition, we would like to look at the debate about private

property and examine the functional side of private property rights especially in relation to markets. The purpose is not to develop possession theory itself. As is commonly known, if it revolves around what private property is, there are also the arguments of Marx, Engels and others to be considered. It is not necessary to develop here the complete argument based on their many points. For us, bearing in mind modern civil society where national power is stabilised and the rule of law and democracy is performed, let it suffice to carry out a comparison of the functional side of private property rights.

4.5.1 Basic model

Certain resources will be written to be R . These resources presuppose that fixed economic earnings are produced and it is assumed that one unit of resources can be exploited by one user. Therefore, if N person exploits the resources, the amount of use will be set to N . Of course, a user also has the option of not exploiting resources. Production functions when N person exploits resources (R) are assumed to be $Q=f(N)$, $0=f(0)$, $f' > 0$, $f'' < 0$, $N \leq \bar{R}$. \bar{R} is resources in which the maximum injection is possible. Furthermore, it is assumed that this production function has the following character (Robson, 2011, p.195).

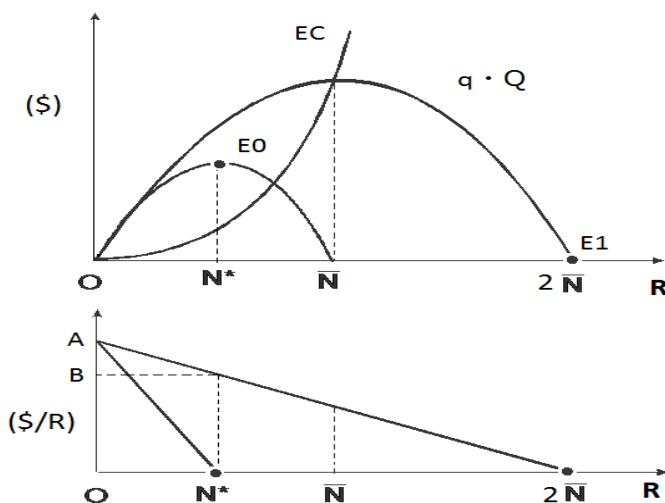


Figure 4.10: determination of a social-optimum point (basic model)

That is, although products increase to the level of a certain resource, it is assumed that the level of production will fall if a certain threshold value \bar{N} is exceeded. And, the level of production becomes zero in being $N=2\bar{N}$. q is a market price per one unit of products here (refer to Figure 4.10). It is reasonable for a production function to become such. Because resources are consumed, certain wastes and contaminants are discharged and accumulated and environmental degradation arises or the reproduction capability of the environment is spoiled. Assuming that the environmental cost EC is evaluated with the currency amount, it becomes $EC(0) = 0$ and $EC'(0) = 0$ at the time of

$N=0$, and $EC(\bar{N}) = q \cdot f(\bar{N})$ at the time of $N=\bar{N}$. And it is assumed that, as a foregone conclusion, it does not appear until a level of production exceeds \bar{N} . But if \bar{N} is exceeded, it will be assumed that environmental damage actualises in a fall in the level of production. It is referred to as $EC' > 0$, $EC'' > 0$. Moreover, it supposes that the sustainable use level Nsd exists in these resources and makes that level into $Nsd < \bar{N}$.

The social welfare function SW (this expresses the issue which society should aim at) is as follows under the above setup.

$$SW = q \cdot f(N) - EC(N) \rightarrow \text{Maximise}$$

Therefore, the maximisation conditions of a social welfare function become $q \cdot f'(N^*) = EC'(N^*)$. That is, it is the point where marginal returns and marginal environmental cost become equal. This situation was shown as point $E0$ in Figure 4.10.

Next, presuppose an individual's action is as follows. A user's resource utilisation is taken as 1 or zero. If N person's user exploits the resources of N unit, the average profit of only $q \cdot f(N)/N$ is expectable. ($1/N$ can be considered to be the profit probability per person when N person enters). It is thought that an individual's action is decided by both equal points in consideration of this average profit and private marginal cost. That is, the average profit has exceeded the private marginal

cost or, when equal, 1, and when less, let the individual amount of resource utilisation be zero.

4.5.2 A share system

Let us consider when a certain property (R) is a common good – that is, the user of resources does not have any restriction.

Although a user's marginal private cost is a fee, the fee is taken as zero. On the other hand, a user's private marginal benefit is $q \cdot f(N)/N$ by assumption. Therefore, the number of resource users further increases and increases to the point that the average profit serves as zero. That is, this shared resource will be exploited until it becomes $N = 2\bar{N}$. The Figure 4.10 and Table 4.4 can explain this situation.

The equilibrium position in the case of a shared resource is set to $E1$ (namely, $N=2\bar{N}$). At this time, a short-term private profit is maximised with area $A2\bar{N}O$. However, this level is clearly in a state of superfluous resource exploitation, in view of the social need for balancing profits and preservation. (This is called **the tragedy of Commons**). It is desirable for $q \cdot f(N) - EC(N)$ to serve as the maximum from a viewpoint of long-term and social resource utilisation. It is in exploiting resources at point $E0$ (namely, $N=N^*$) that the social marginal earnings and marginal environmental cost become equal (refer to Figure 4.10 and Table 4.4).

	Social optimisation	Private optimisation
Marginal profit	$q \cdot f'(N)$	$q \cdot f(N)/N$
Marginal cost	$EC'(N)$	0
Necessary condition	$q \cdot f'(N) - EC'(N) = 0$	$q \cdot f(N)/N = 0$
Desirable degree of resource utilisation	N^*	$2\bar{N}$

**Table 4.4: comparison of social optimisation and private optimisation
(share system)**

After all, the sharing (or share system) of resources will bring about the superfluous exploitation of resources and the shared resource will deteriorate.

The economic reason for this can be explained using the lower half of Figure 4.10.

As the size of the expected profit by the entry of a person of average profit is shown to increase, it can be interpreted as showing the size of private marginal net earnings (= average profit—marginal private cost = average profit). Because the entry person can ignore environmental expense if social marginal net earnings ($= q \cdot f'(N) - EC'(N)$) are compared with private marginal net earnings, the private marginal net earnings will be larger and the social marginal net earnings will disappear early with the increase of people entering (increase in availability of resources).

In order to avoid this, the management of resources is put into public ownership (such as by creating a national park) which makes it possible to take a fee from the users of resources. For example, if a charge of the height of B in Figure 4.10 is collected from each user, the number of people entering can be restricted to N^* . However, the problem of how to presume EC function and as how much to set a fee is left behind. Moreover, when creating a national park, the use of resources as economic goods must be extremely restricted.

Another solution that cancels the ‘tragedy of the commons’ is the introduction of the right of private property. Another choice is to restrict the exploitation of resources to a specific area or a specific organisation in order to regulate the number of persons using the resource. It is a way of making the organisation pay the administrative and maintenance expenses of the resources. Many commons and local resources (the public land of a village, rights to beaches or river use etc) balance use and preservation by such a method. This method manages a resource that is used and shared by clubs and similar organisations. However, whether the managing organisation always maintains availability at the level of N^* needs to be supervised. This is because the organisation can easily gain higher corporate profits by increasing availability.

4.5.3 Management of shared resources using private property rights

4.5.3.1 Package private ownership system

Private property rights are accepted over resources and are considered private possessions. Let us consider the case where resources are collectively sold to a private owner. When the private owner of resources is called an 'owner', the owner makes demands on the user of the resources for a fixed counter value and the use price (p) is the method of entrusting negotiation between a user and an owner.

The problem an owner should solve is maximisation of private profit $= p \cdot N - EC(N)$, and a user's action, maximisation of $q \cdot f(N) - p \cdot N$. So, $p = EC' (N)$, is obtained from the former equilibrium condition. This is an owner's supply curve. $p = q \cdot f' (N)$ is obtained from the latter equilibrium condition. This is a user's demand curve. Therefore, a seller and a buyer negotiate a fee and when the equilibrium position (p^0, N^0) used as $p^0 = EC' (N^0) = q \cdot f' (N^0)$ is discovered, the use price p is decided as p^0 . Maximisation condition of the social welfare function SW , i.e.

$q \cdot f' (N) - EC' (N) = 0$, is then filled exactly and the desirable use level $N^0 = N^*$ can be automatically found through a market. This is the merit of introducing a market and the right of private property.

The exploitation of resources is performed efficiently and the prices (p) for use of the resources are determined automatically. However, when the owner of the resources collects a fee as a monopolist, the use prices p of resources are high and it is possible that the availability becomes low. In this case, the evil of monopoly may occur.

4.5.3.2 Division of private ownership system

Next, we will consider the case where resources are not sold to an individual collectively, but divided and sold to individuals. Dividing resources into m pieces, for simplicity's sake, presupposes that all the resource portions are equal. That is, m persons will own the resources of $\frac{\bar{R}}{m}$ each privately.

Each one of the private production functions will be set to $Q_i = f_i(N_i) = f(N_i)/m$ ($i = 1, 2, \dots, m$), and we will presuppose the products are the same. Then, since each private owner turns into a private producer simultaneously, the action serves as maximisation of $q \cdot Q_i - EC_i(N)$. (Expenses, such as wages, will be ignored). Here, EC_i is the environmental cost at the time of being managed privately and is taken as $EC_i(N_i) = EC(N_i)/m$. Then, the necessary condition for maximisation is set to $q \cdot f'_i(N_i) = EC'_i(N_i)$ ($i = 1, 2, \dots, m$). Supposing it is set to $\Sigma q \cdot f'_i(N_i) = q \cdot f'(N)$ and $\Sigma EC'_i(N_i) = EC'(N)$, $q \cdot f'(N) =$

$EC'(N)$ is realised. This will be the same as the maximisation conditions of a social welfare function. Also, in a division of private ownership system, production activity and resource preservation will be compatible.

However, can a private person expect to perform sufficient expenditure for EC_i ? EC_i can be evaluated as low priority because immediate profits are being pursued. Moreover, information about the environmental state would be collected from a private person's position, so there would be a limit to making relevant comparisons with the environment in the long run and in the short term. Furthermore, dividing and exploiting resources has a high possibility of generally improving productivity. Supposing productivity increases by division, or the underestimation of environmental expense occurs (or both occur), as shown in Figure 4.11, there is a high probability that in the case of private ownership the collective welfare function will expand and superfluous exploitation of resources will arise.

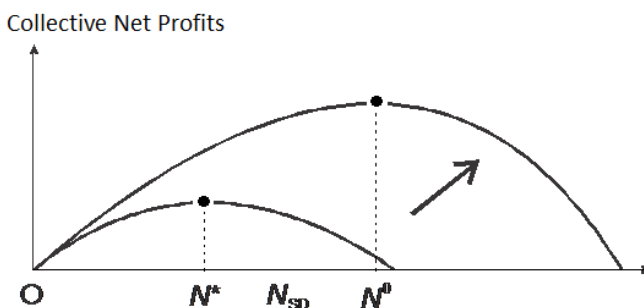


Figure 4.11: the problem of the division of private ownership system

In this case, it cannot be said that the use of resources by the division of private ownership management is necessarily the optimal.

4.5.4 Private ownership system and sustainability

The following problem occurs in a private ownership system. When marginal environmental preservation costs and marginal profits are in agreement, although social or private benefits become the maximum, it is not known whether N^* is truly a level that enables continuation of resources over a long period of time.

Even if it is changeless for ten years, an accident may occur in the environment in 50 or 100 years. It is difficult for a private producer to consider such a long-term environmental change and to pay expenses appropriately. Then, N^* and Nsd may cross each other or the relation between N^* and Nsd may change with degradation where the environment is not in sight depending on a situation. A private ownership system does not fully function under such a change.

We will summarise an argument for the above.

- If there are not suitable usage restrictions or a fee system when managing resources by a sharing system, superfluous use will result. (Management of a shared

resource can have collective management by clubs, such as regional organisations or a cooperative, or state control can be enacted by making into national park etc).

- For resources over which private ownership is possible, it is desirable to have a private ownership system and a market. Even in such a case, since there is the possibility of superfluous exploitation of resources and monopoly, the responsibility for production control and environment management should be separated, and it is desirable to entrust a private producer with efficient control of production.
- As a private producer's action is generally insufficient to manage the environment, it is desirable to entrust this to public management.

4.5.5 Private ownership systems and inefficiency

Generally, the private ownership system has an outstanding function that promotes the efficient use of resources by coexisting with a market. However, it is important to understand that inefficiency may still be included in a private ownership system.

Now, assume that the resources \bar{R} are owned privately.

Supposing the owner utilises these resources, we will presuppose that only $q \cdot f(R)$ of private economic earnings are

obtained. However, only α per cent exploits resources for a certain reason, and the resources of $(1 - \alpha) \cdot \bar{R}$ presuppose that it is not used. For simplicity's sake, let the resource price be zero. Therefore, the size of the resource opportunity cost that is not used in this case can be expressed as a domain of Figure 4.12.

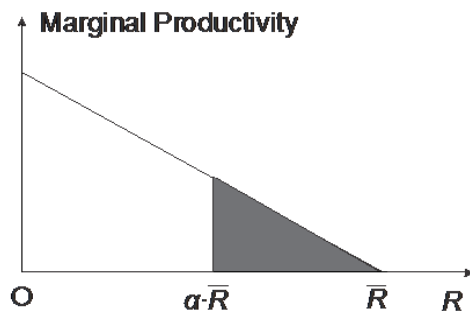


Figure 4.12: outbreak of inefficiency

In this case, since under-utilisation of resources has clearly occurred, seen from a viewpoint of efficiency, private property rights will be set to untapped natural resources, which should be utilised effectively. However, when an excellent manager is not found and/or a successor cannot be easily secured and an employer required is not found for production either, the most desirable solution will be for a state to deprive the inefficient person concerned of the right of private property (after paying a fixed counter value) and sell the right of resource utilisation to a

more efficient private owner. (The agrarian land reform of Japan after the Second World War had just such an intention).

However, apart from some unique exceptions, this is not the reality of the situation. There are various reasons for this and the biggest would probably be the problem of distrust over money. Although money loses value with the bankruptcy of a state or a bank, since resources do not go bankrupt, they do not lose use value. In an uncertain age where the value of money is not especially stabilised, there is absolute value (or a sense of security) in supporting minimum survival in resources. However, money does not have such a function. There is no use value in money (bills) and when goods exist the exchange is only mediated. Therefore, even if resources cannot be used now, in order to secure safety at its minimum, or for future posterity, owners try not to part with them. And since the property right is not to be taken even if the right does not use resources appropriately in an actual capitalist economy (especially when owned and managed by the same person), resources can be easily held over a long period of time, while intact.

If the right for such risk management is contained in the right of private property at all, the opinion that a private property system is efficient always requires a proviso. That is, the right of private property is compatible with efficiency because it assumes tacitly that there is the intention of managing this right

100 per cent appropriately, and that a good economic player with power of execution always exists. Therefore, a private ownership system is by no means a perfect system, but is a system that may include fixed inefficiency. In order to operate it efficiently, suitable measures should be taken. The operational side of the resources should always be specifically supervised by surveillance, laws and regulations etc from the outside, and the objective mechanism of adding improvement should be required.

It may become an institutional strength to hold this inefficiency depending on the case. For example, in the case of the water market, there are water rights which are excessive and do not need to be used even though they are held (this is called **sleeping water rights**), and water rights which are held but not performing any production activity (this is called **dead water rights**). This has probably arisen especially in developing countries undergoing rapid modernisation accompanied by a rapid reduction in the population of agricultural villages.

The conventional right of crop irrigation fully remains such a case. Such surplus water rights not only have never had a negative influence on the water market, but have had a positive side (especially in drought). For example, although all the water rights should be reduced by 50 per cent, ostensibly in the case of 50 per cent drought, if the sleeping water rights and dead water rights can be activated through a water market, 50 per cent or

more of water can be used substantially. That is, rights that are not used function as a buffer in an emergency.

In conclusion, a social system may require a certain amount of futility. However, excessive inefficiency is a prohibited factor. It is this writer's opinion that although a certain amount of inefficiency may be accepted a penalty should be imposed on inefficiency over a long period of time. For example, water rights not used for ten years or more and that do not accept updating, or measures such as imposing a fixed fine to updating, should be taken. When water rights have so far been held for nothing, I think a rational charge should be set up when updating water rights.¹

4.5.6 Water rights as a right of private property

Although labour, land and water are important as resources, in the 1960s or after, water came to be used as a private good, as compared with the commercialisation of land and labour.² We consider the commercialisation of land to have happened at the time Parliamentary Enclosure was completed around 1860. Commercialisation of the labour force happened around the time

¹ There has been discussion about the end of the right to not use water rights in Australia. Refer to Phillips Fox, 2004, p.5 for detail.

² There is a description of this being carried out by the North Poudre Irrigation Company [NPIC] of North Colorado, USA early in the 1960s in Field, 2001, p.311).

1715. Thus, it would be reasonable to say the commercialisation of water happened from 100 to 250 years later, compared to that capitalism was created by the Industrial Revolution, and Savery and Newcomen's steam engine company was established around of land and the labour force. We would like to consider the reasons for this.

First, some conditions are required in order for something to be dealt with as goods in a market.

The main conditions are as follows:

- (1) Quantitative measurement and quantitative invariability
- (2) The right of use (exclusiveness) and transferability
- (3) Low transaction costs including delivery cost
- (4) Reduction by use (competitiveness or no-free goods).

(1) Compared to land, water management is difficult on this point. For water to reach a state of being manageable, containers are needed, or there has to be the construction of water supply equipment and water service equipment etc. Even in such a case, supply could be stopped due to natural phenomena, such as a drought. Moreover, there would be a loss on various deliveries due to evaporation or leakage.

(2) The right of use must be transferred from Mr A to Mr B, and for B to be in a position to actually be given property of the

resource by sales contract. For that purpose, it must be possible to decide what Mr A's possessions are. For example, in the case of groundwater, it is difficult to distinguish Mr A's groundwater and Mr B's groundwater accurately. In order to distinguish this, water rights are set up around the amount of inflow of groundwater every year, construction of a well is made by a licence system, there is a legal duty imposed to install a measuring instrument for groundwater use, and a complicated managerial system of reporting the amount used periodically etc is needed.

(3) In order to exploit the water resources in the land of Mr A and in the land of Mr B, the infrastructure and administrative and maintenance expenses for moving water are needed separately. Dealings will not be materialised if the expenses concern movement of water total a large sum. Similarly, dealings will not be materialised if the expenses for finding out the seller and the buyer of water is high.

(4) Goods that are the targets of private property must not be goods that anyone can use freely. In other words, rivalry in consumption must exist. For example, the reason the right of private property cannot be set on the use of sunlight is that the amount of sunlight does not decrease by a certain person's use, and people's use of it is not barred. Although such goods are called **free goods**, water has the free goods character of a

present from the heavens in one aspect (in the case of rain). However, we should think of water whose use was attained only after artificial diversions and water-purifying plant were built – and water supply and drainage infrastructure are not free goods. In that case, water is the target of co-owning (for example, rural residents' co-owning) or of private ownership.

Therefore, when considering water to be an object of private property, we have to distinguish the following points:

(1) Water that is not (or cannot be) a proprietary target for dealing – what has competitiveness in neither use nor consumption, e.g. rain or flood.

(2) Water that is a proprietary target for dealing– that has competitiveness in use or consumption:

(2-1) Water whose use was attained by the collective and cooperative building of an artificial thing, e.g. the water for cities that was attained by dam construction, industrial water, water for agriculture that was attained by dam construction, a shared reservoir, a shared well, etc.

(2-2) Water whose use was attained through the individual building of an artificial thing, e.g. an individual well, individual reservoir.

When construction of a diversion and water supply/drainage institution is required for an exclusive right-of-use setup for water as described in point (2), the water will be in a

manageable state as an object of private property. In other words, it can be said that the reason for the delay in the commercialisation of water was the lack of infrastructure for setting up the exclusive right of water use, and when the economic means were available, the transaction costs were too high. (It can be said that 100 years were required to reduce the transaction costs of water as compared with land).

However, in the 1930s when large-scale dam construction became possible and irrigation agricultural waterways, city purification institutions, water supply institutions etc were created by the development of civil engineering, the conditions for managing water as a subject of private property were met at last. Income was required in order to actually maintain such large-scale infrastructure and, with the spread of water services, paying a charge to use water became common. Looked at this way, in a present-day capitalist society the commercialisation of water and the introduction of the water market have already become technically possible and, within the limits of (2), we can set the kinds of ownership of water and can choose the method of how to manage water resources using ownership. In other words, we have reached a time when we can choose whether water resources management using ownership is performed.

	Labour	Land	Water
Measurement nature	easy (usually)	easy	slightly difficult
Stability of supply	stable (usually)	stable	probable depending on the weather
Registration and a setup of the right of use	easy	easy	difficult
Risk of possession	low (usually)	low	high (evaporation and leakage)
Maintenance cost	low (usually)	low	high
Reuse possibility at the time of being drained	possible	impossible	possible

Table 4.5: comparison of labour, land and water as an object of private property rights

Chapter 5

Equilibrium Points in Water Markets

Section 1: Introduction

This chapter deals with a fundamental problem of water markets: the method of pricing. It is an issue that has not yet been fully studied by Australian publications, even though the method of pricing water markets is peculiar to Australia. In particular, research has not yet been done on pricing methods when information is discontinuous. This chapter is a detailed examination of these cases.

Although there are other methods for pricing water markets (e.g. auctions), the system used in northern Victoria until August 2012 is used in this study. In August 1998 in northern Victoria, in order to secure the transparency of commercial information and to promote water trading, the Northern Victoria Water Exchange was founded. The ‘double bids’ pricing system was devised and a water price was determined once every week during an irrigation season. This system became the basis of Watermove, the full-scale internet market founded in 2002. However, details of Watermove and the Victorian government are sparse, so there is a need for more detailed pricing analysis (refer to Watermove’s webpage and DNRE, 2001b).¹

¹ Watermove closed in August 2012. See Table 1.10 in Chapter 1.

Section 2: Order Set and Cumulative Curves

5.2.1 Order Set

In Watermove, participants can create orders on the internet after using a login ID and a password. Participants must register the trading zone, volume for trade in megalitres, price per megalitre, and set up an order number for the sale. The information on expected market prices and the quantity (that is, price per megalitre, volume for trade in megalitres), here will be called an ‘order’ or an ‘**order set**’.

The seller’s order set presupposes the following:

$$\text{Seller} = \{(ps_1, s_1), (ps_2, s_2), (ps_3, s_3), \dots, (ps_n, s_n)\}.$$

Here, ps_1 is the first seller’s selling price and, similarly s_1 is the volume of sales. It is assumed that the seller’s order set is ordered sequentially from the lowest selling price. Moreover, the order that presented the same selling price assumes that it is ranked in order of number (or time). Therefore, it is assumed that $ps_1 \leq ps_2 \leq ps_3 \leq \dots \leq ps_n$ is realised. n is the total of a selling order.

Similarly, the buyer’s order set presupposes the following:

$$\text{Buyer} = \{(pd_1, b_1), (pd_2, b_2), (pd_3, b_3), \dots, (pd_m, d_m)\}.$$

Here, it is assumed that the buyer order set is ordered sequentially from the high order of the purchase price. Namely,

it is assumed that $pd_1 \geq pd_2 \geq pd_3 \geq \dots \geq pd_m$ is realised. m is the total of a buying order.

Clearly, ps_1 is the minimum offer price in a seller's order set, and pd_1 is the maximum offer price in a buyer's order set.

At this time, the selling order exceeds the maximum offer price (pd_1), i.e. the selling order that becomes $ps_i > pd_1$ cannot find a buying order.

Then we define an effective seller's order set (ESeller) by excluding orders in which the price exceeds pd_1 from the seller's order set (Seller). Namely,

$$ESeller = \{(ps_i, s_i) \mid ps_i \leq ps_i \leq pd_1 \text{ and Seller}\}.$$

Similarly, we define an effective buyer's order set (EBuyer) by excluding orders of a price lower than ps_1 from the seller's order set (Seller). Namely,

$$EBuyer = \{(pd_j, b_j) \mid ps_1 \leq pd_j \leq pd_1 \text{ and Buyer}\}.$$

In addition, the 'difference of sets' between a seller's order set and an effective seller's order set and the 'difference of sets' between a buyer's order set and an effective buyer's order set is called the **First Exclusion Order Set**. These are orders that are not allowed to participate in dealings so to speak, therefore do not participate in the formation of a market equilibrium price.

First Exclusion Order Set = $\{\text{Seller} - \text{ESeller}\} \cup \{\text{Buyer} - \text{EBuyer}\}$.

Although the order of ESeller is located from low to high price, it reattaches an order number from l anew and sets the total to n anew. Similarly, although the orders of EBuyer are located from high to low price, it reattaches an order number from l anew and sets the total to m anew.

5.2.2 Numerical Example

Two numerical examples will be described – one with virtual data (example 1) and the other with real data (example 2).

Example 1:

The left-hand side of Table 5.1 expresses a seller's order set and right-hand side expresses a buyer's order set.

Seller's Order Set			Buyer's Order Set		
N0	Price(A\$/ML)	volume(ML)	No	Price (A\$/ML)	volume(ML)
s1	80	20	b1	250	10
s2	100	30	b2	200	20
s3	150	30	b3	180	30
s4	180	50	b4	150	50
s5	200	50	b5	100	30
s6	250	50	b6	80	10
s7	300	10			

Table 5.1: a virtual numerical example of seller's and buyer's order sets

In this numerical example, a seller's order set is arranged in order from lower to higher prices. A buyer's order set is arranged in order from higher to lower prices. The seller's price range is A\$80 to A\$300 per ml, and the buyer's price range is A\$ 250 to A\$80 per ml. In the case of this numerical example, the first exclusion candidate is s7.

Example 2:

In Watermove, the water market was opened from 6 August 2009 to 3 June 2010. In that time, 42 dealings were conducted on Thursday every week, except for two occasions in the Christmas holidays.

In the dealings on 28 January 2010 for allocation for zone 1A, there were 91 orders from sellers and 60 orders from buyers. The seller's price range was A\$49 to A\$350 per ml and the buyer's price range was A\$ 300 to A\$50 per ml.

Moreover, the seller's volume range was 2 to 700 ml and the buyer's volume range was 1.5 to 600ml. One affair (s91) became the target of the first exclusion.

Seller's Order Set			Buyer's Order Set		
No.	Price(A\$/ML)	volume(ML)	No	Price(A\$/ML)	volume (ML)
s1	49	3.1	b1	300	1.5
s2	110	48.1	b2	250	30
s3	112	98.1	b3	248	50
· ·	· · ·	· · ·	· ·	· · ·	· · ·
s89	300	90	b59	71.5	36
s90	300	30	b60	50	200
s91	350	10			

**Table 5.2: actual numerical example of seller's
and buyer's order set on 28 January 2010**

(Source: <http://www.watermove.com.au/>, accessed 20 August 2011)

5.2.3 Cumulative Curves

The cumulative supply curve (CSC) is defined as follows:

$$CSC = \{(ps_1, c_1), (ps_2, c_2), (ps_3, c_3), \dots, (ps_n, c_n) \mid \text{ESeller}\},$$

where $c_i = s_1 + s_2 + \dots + s_i$ ($i = 1, 2, \dots, n$). (n is a total of the components of ESeller.)

This cumulative supply curve can be interpreted as a supply curve if we can regard a different seller's orders as an additional (or marginal) selling order of the same person.

Similarly, a cumulative demand curve is defined as follows:

Cumulative Demand Curve (CDC) =

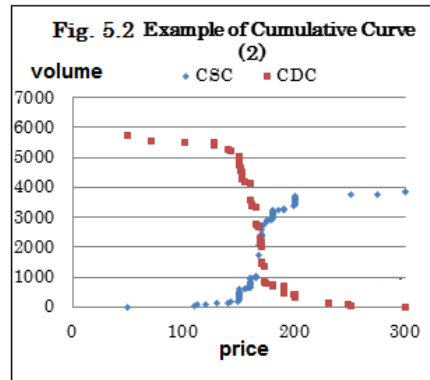
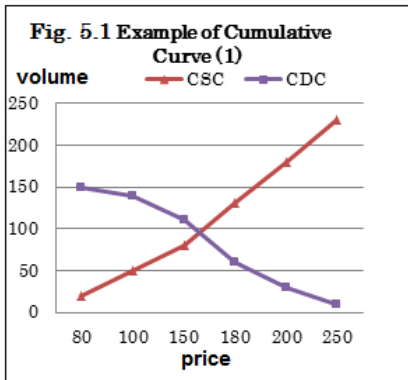
$$\{(pd_1, d_1), (pd_2, d_2), (pd_3, d_3), \dots, (pd_m, d_m) \mid \text{EBuyer}\},$$

where $d_j = b_1 + b_2 + \dots + b_j$ ($j = 1, 2, \dots, m$). (m is a total of the components of EBuyer.)

This cumulative demand curve can be interpreted as a demand curve if we can regard a different buyer's orders as an additional (or marginal) buying order of the same person.

Numerical example:

The cumulative curves of the numerical examples explained in 5.2.2 are as follows, respectively.



Section 3: Tatonnement and determination of equilibrium point (when theoretical)

The process of looking for a market equilibrium point (known as tatonnement) is described as follows.

The sufficiently small selling price between $[ps_1, pd_1]$ on CSC, for example, ps_i , is chosen arbitrarily. The volume

ingredient on CSC corresponding to ps_i is set to c_i . Next, the volume ingredient on CDC corresponding to ps_i is set to d_i . (When there is no volume ingredient corresponding to ps_i on CDC, the volume ingredient on CDC which approaches ps_i most shall be chosen).

A market is considered to have excess demand (namely, $d_i - c_i > 0$) when ps_i is small enough. Then, a price increases to $ps_{i+1} (> ps_i)$.

In this way, the selling price is gradually moved upwards so that $|d_i - c_i|$ may gradually decrease and a price level in a case where the sign changes from plus to minus (i.e. when it changes from excess demand to excess supply) is found.

We will set a price level before and after a sign changes to ps_k and ps_{k+1} . (Volume of the supply side corresponding to ps_k is set to c_k , and volume by the demand side is set to d_k).

Here, two cases are distinguishable.

(1) If $|d_k - c_k| > |d_{k+1} - c_{k+1}|$, then an equilibrium price will be ps_{k+1} . And, then the equilibrium volume will be the smaller one of d_{k+1} and c_{k+1} . Since it is $d_{k+1} < c_{k+1}$ in this case, the equilibrium volume will be set to d_{k+1} and the order by the supply side will not be filled only for $\varepsilon_1 (\varepsilon_1 = |d_{k+1} - c_{k+1}|)$. (In

this case, the ‘third exclusion’ occurs in the buyer’s side. This will be discussed later).

(2) If $|d_k - c_k| < |d_{k+1} - c_{k+1}|$, then an equilibrium price will be ps_k . And then the equilibrium volume will be the smaller of d_k and c_k . Since it is $c_k < d_k$ in this case, the equilibrium volume will be set to c_k and the order by the demand side will not be filled only for $\varepsilon_2 (\varepsilon_2 = |d_k - c_k|)$. (In this case, the ‘third exclusion’ occurs in the seller’s side. This will be discussed later).

This so-called **minimisation principle** is the method of determining an equilibrium point.

When it is decided that an equilibrium price will be p^* , the sellers belonging to ESeller who set up the price of more than p^* cannot sell off water, as the above-mentioned explanation demonstrates. Similarly, the buyers belonging to EBuyer who set up the price below p^* cannot purchase water. This is called the **second exclusion**, and the order set eliminated second (second exclusion order set) can be expressed as follows:

$$\begin{aligned} \text{Second exclusion order set} = & \{(ps_i, s_i) \mid ps_i > p^* \text{ and ESeller}\} \\ & \cup \{(pd_j, b_j) \mid pd_j < p^* \text{ and EBuyer}\}. \end{aligned}$$

Next, the remaining set that performed the second exclusion among each effective order set (ESeller and EBuyer) is

considered. These are sets of those who succeeded in water dealings and they can be described as follows.

Successful seller's order set (SESeller)=

$$\{(ps_i, s_i) \mid ps_i \leq p^* \text{ and } ESeller\},$$

Successful buyer's order set (SEBuyer)=

$$\{(pd_j, b_j) \mid pd_j \geq p^* \text{ and } EBuyer\}.$$

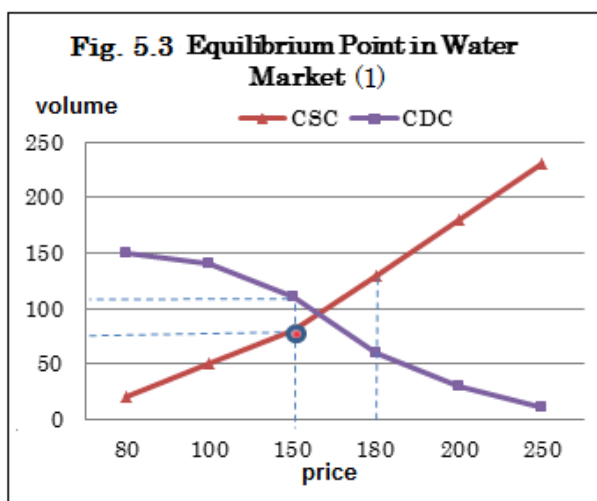
All the participants belonging to these sets can succeed in water dealings and can deal in water. However, in order to balance supply and demand, some of the last seller(s) or buyer(s) have to have water supply or water demand reduced to only ε_1 or ε_2 . This person is called the candidate of the third exclusion. Finally, the **third exclusion** defines that only ε_1 or ε_2 deletes water supply or water demand out of the success of water dealings. (In Watermove, whose water is finally reduced out of those who placed an order for the equilibrium price of the same level is determined by a random ballot using a computer. Refer to About Water Trading on the Watermove web page for details).

Looking at the water market from participants' perspective, those who succeed in dealings will say it is equal to those who were not the targets of the first exclusion and second exclusion. Moreover, since supply and demand are finally balanced, the last seller(s) or a buyer(s) may have a part of the water dealings

reduced. These factors (especially the second exclusion) can be realised to be the risks in the case of participating in water dealings and it is thought that it becomes a cause for reducing the incentives for participation (refer to Appendix, Chapter 13 for ‘dealings strike rate’).

Numerical example:

We will illustrate the determination of the equilibrium point in a water market using the numerical example in Section 2 (5.2.2).



If the price is set to 80, the supply volume is 20 and the demand volume is 150, the excess demand volume becomes 130. If a price is raised to 100, the excess demand will be set to 90. If a price is raised to 150, the excess demand volume will be set to

30. Furthermore, if a price is raised to 180, the excess demand volume will serve as minus 70. Since the excess demand volume changed from plus to minus when a price was moved to 180 from 150, an equilibrium price becomes either 150 or 180 in this case. Since the absolute value of difference is small in a case when the price is 150, an equilibrium price is set to 150.

When an equilibrium price is set to 150, supply volume is 80 and demand volume clearly at 110, and the supply volume is smaller than the demand volume. Then, the equilibrium volume ends up at 80 in this case. In addition, although the b4 took out the buying order of 50, because the seller corresponding to it is not found in 30 of them, 30 is cut among 50.

As a result, in this dealing, the seller of s1, s2, and s3 can sell the desired amount of water. On the other hand, although the buyer of b1, b2, and b3 can purchase the desired amount of water, only 20 can be purchased among b4's orders of 50.

In other words, in this dealing, the seller of s4, s5, s6, and s7 cannot sell water. Also the buyer of b6 and b5 cannot buy water and 30 of b4's orders of 50 cannot be purchased. (For the participant in this virtual dealing, there were seven sellers and six buyers. One seller became the target of the first exclusion. Three of the sellers and two of the buyers became the targets of the second exclusion. And, one buyer became the target of the third exclusion and 30ml of this seller's order was reduced).

It can be said that a market equilibrium point will be decided by the intersection of a cumulative supply curve (CSC) and a cumulative demand curve (CDC) supposing it can be assumed that an order exists continuously in the first place. In Watermove this equilibrium price is called the ‘pool price’.

However, this explanation only holds when each curve is continuous. The actual order is limited and discontinuous and, moreover, required data for determining excess demand are lacking in many cases. In such a case, how can an equilibrium point be decided?

Section 4: Schedule Table and Integrated Table

5.4.1 Schedule Table

First, the following calendars are made using CSC and CDC which were explained in Section 3. We call this the ‘**schedule** or **schedule table**’.

Price (A\$/ML)	Seller's Schedule (ML)	Price (A\$/ML)	Buyer's Schedule (ML)
ps_1	c_1	pd_1	d_1
ps_2	c_2	pd_2	d_2
ps_3	c_3	pd_3	d_3
.
ps_n	c_n	pd_m	d_m

Table 5.3: schedule table

Note: $ps_1 \leq ps_2 \leq ps_3 \leq \dots \leq ps_n, pd_1 \geq pd_2 \geq pd_3 \geq \dots \geq pd_m$,

$$c_i = s_1 + s_2 + \dots + s_i \ (i=1, 2, \dots, n), d_j = b_1 + b_2 + \dots + b_j \ (j=1, 2, \dots, m)$$

We will give an example.

The following sets a price range from 165 to 170 among the temporary water dealings on 28 January 2010 of zone 1A in northern Victoria and extracts some data (cf. Table 5.2).

Price (A\$/ML)	Seller's Schedule (ML)	Price (A\$/ML)	Buyer's Schedule (ML)
165	1012.8	170	2118.5
165	1042.8	169	2193.5
167.92	1742.8	168.6	2293.5
168	2042.8	168	2673.5
169.50	2185.8	166	2723.5
170	2195.8	165.22	2748.5
170	2295.8	165	33485
170	2315.8		

Table 5.4: the schedule table created from some data on 28 January 2010
(Source: <http://www.watermove.com.au/>, accessed 20 August 2011)

5.4.2 Integrated Table

An **integrated table** rearranges the buyer's schedule in order of size and also unifies the seller's schedule and the buyer's schedule and places them in order of size.

Thus, when an integrated table is constituted, there is a blank space that lacks a numerical value corresponding to a price. Suppose that it proceeds as follows at this time.

When c_U of the supply volume is missing to a certain price level $ps_U(>ps_L)$ in the case of a seller, it is thought that a higher price than ps_L can also be supplied, as for the supply volume c_L of the price ps_L lower than ps_U . Therefore, in the case of a seller, the supply volume c_L of a price level ps_L is entered also in the blank under c_L (refer to Table 5.5).

When d_L of the demand volume is missing to a certain price level $pd_L(<pd_U)$ in the case of a buyer, it is thought that a lower price than pd_U can also be demanded, as for the demand volume d_U of the price pd_U higher than pd_L . Therefore, in the case of a buyer, the demand volume d_U of a price level pd_U is entered also in the blank upper d_U (refer to Table 5.5).

Using the above process, the amount of excess demand corresponding to each price level is calculable.

An example of an integrated table is shown in Table 5.5.

Price (A\$/ML)	Seller (ML)	Buyer (ML)	B-S (ML)
165	1012.8	3348.5	2335.7
		↑	
165	1042.8	3348.5	2305.7
	↓		
165.22	1042.8	2748.5	1705.7
	↓		
166	1042.8	2723.5	1680.7
167.92	1742.8	2673.5	930.7
		↑	
168	2042.8	2673.5	630.7
	↓		
168.6	2042.8	2293.6	250.8
	↓		
169	2042.8	2193.5	150.7
169.5	2185.8	2118.5	-67.3
		↑	
170	2195.8	2118.5	-77.3
		↑	
170	2295.8	2118.5	-177.3
		↑	
170	2315.8	2118.5	-197.3

**Table 5.5: the integrated table created
from some data on 28 January 2010**

Section 5: Tatonnement and determination of equilibrium point (when actual)

5.5.1 Rough Estimation of Equilibrium Point and Criterion of Judgments Point

According to the integrated table, we can estimate the equilibrium point. For example, the sign of excess demand is reversed as a price level rises from 169 to 169.5 in the case of Table 5.5. Then, although it is thought that an equilibrium point is around here, since Table 5.5 has filled up missing data, when it is decided that it will be a certain price level, it does not have the deterministic guarantee of whether demand and supply are certainly securable by that price level.

Excess demand presents a more positive possible outcome.

In the present example (Table 5.5), we have a case where a price is 168 and the amount of excess demand is 630.7, and a price is positive when 170 and excess demand are -197.3.

If these two cases are compared from the viewpoint of the minimisation principle as provided in Section 3, the excess demand of the smaller one is the case where the price is 170 and excess demand is -197.3, judging in an absolute value.

In this way, when the amount demanded and the amount of supply correspond to a certain market price we will call the combination expected a trustworthy **criterion of judgments point**. As for a criterion of judgments point, it is desirable to

approach the equilibrium point as much as possible. Thus a criterion of judgments point is the combination of price = 170 and volume = 2118.5 (refer to Figure 5.4).

Judging from the general method (minimisation principle) considered in Section 3, it seems that the equilibrium point in this case is a criterion of judgments point.

However, further examination is required.

5.5.2 Actual Equilibrium Point

Figure 5.4 illustrates the neighbourhood of the criterion of judgments point of the data on 28 January 2010.

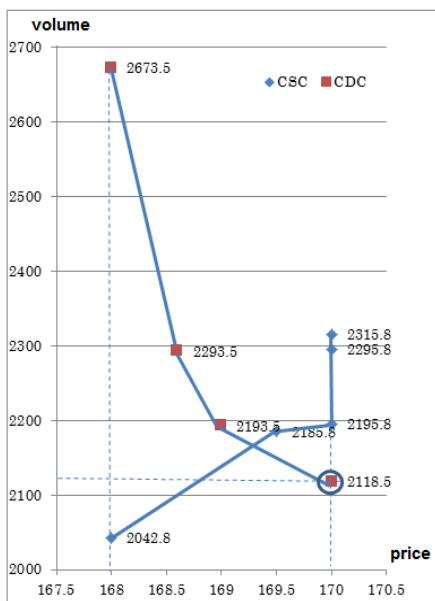


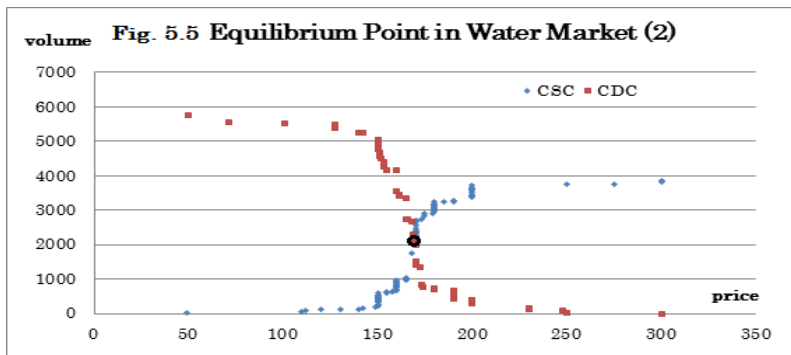
Figure 5.4: an example of a criterion of judgment point

Based on a criterion of judgment point, the equilibrium volume is set to 2118.5. To decide these dealings, 2118.5 or more demand and 2118.5 or more supplies should exist. In order for 2118.5 or more demand to exist, the equilibrium price should be 170 or less. For 2118.5 or more supplies to exist, the equilibrium price should be 169.5 or more.

When a price is 170, this condition is fulfilled, but when an equilibrium price is set to 170, three sellers who set the selling price to 170 cannot sell water, although an equilibrium price is 170 (refer to Figure 5.4).

Such a situation has a high possibility of generating unreliabilities in the water market. In order to soften a seller's dissatisfaction, the equilibrium price must become smaller than 170. That is, it will be said that the equilibrium price should just be between 169.5 and 170.

Then, simply, an equilibrium price will be set to $(170+169.5) / 2 = 169.75$, if the prices of two persons stated in the above are halved. This means all that is necessary in this case is to set the equilibrium price of water as 169.75 (refer to Figure 5.5).



In the example in Section 4, an equilibrium point is decided as equilibrium price = 169.75 and equilibrium volume = 2118.5. This explains the result of the actual water market in zone 1A on 28 January 2010. (There were 91 sellers and 60 buyers dealing on 28 January 2010 in Watermove. One seller became the target of the first exclusion. Forty-three sellers and 29 buyers became the targets of the second exclusion. One seller became the target of the third exclusion and 67.3ml of this seller's order was reduced).

Section 6: The case of an Imperfect Criterion of Judgments Point

(1) Schedule table

It can be said that the example of Section 5 is a case where the equilibrium point and the criterion of judgments point are extremely close and is easy to treat. We will consider the case

where the criterion of judgments point is sharply shifted from the equilibrium point. The following are some data from the water market on 6 May 2010.

Price (A\$/ML)	Seller's Schedule (ML)	Price (A\$/ML)	Buyer's Schedule (ML)
75	1094.8	80	1016
75	1104.8	78.96	1216
78	1194.3	75	1316
78	1242.8		
79	1292.8		
79	1392.8		
80	1452.8		
80	1463.4		

Table 5.6: a schedule table of data from 6 May 2010

(2) An integrated table is as follows.

Price (A\$/ML)	Seller (ML)	Buyer (ML)	B-S (ML)
75	1094.8	1316	221.2
75	1104.8	1316	211.2
78	1194.8	1216	21.2
78	1242.8	1216	-26.8
78.96	1242.8	1216	-26.8
79	1292.8	1016	-276.8
79	1392.8	1016	-376.8
80	1452.8	1016	-436.8
80	1463.4	1016	-447.4

Table 5.7: integrated table using data from 6 May 2010

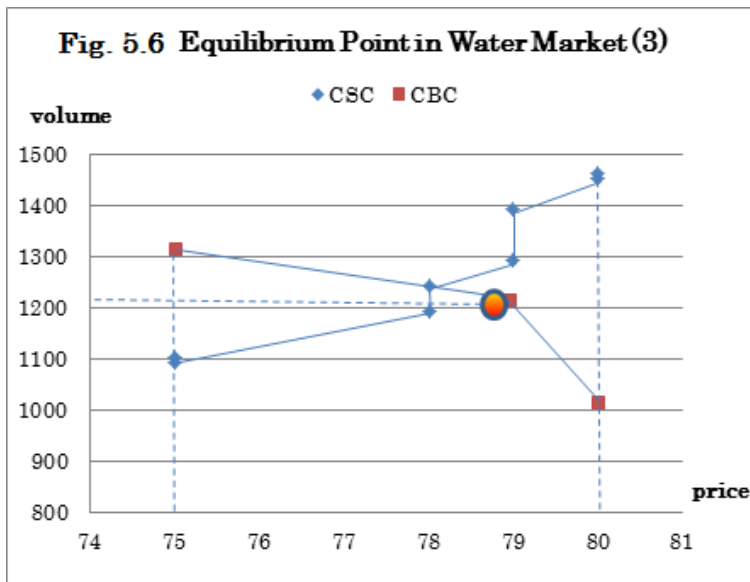
(3) Rough estimation of an equilibrium point

An equilibrium price level is 78 to about 78.96.

(4) Imperfect criterion of judgments point

Although the criterion of judgments point is the combination of price = 75 and volume = 1104.8 in this case, it has separated a little from the range considered to be an equilibrium price (refer to Figure 5.6). Then, we can find another possible point (78.96, 1216) nearer to an equilibrium price. In this point, 1216 of demand certainly exists but supply is not trustworthy. I will call this an **imperfect criterion of judgments point**. Then, an equilibrium dealings level is set to 1216.

The neighbourhood of an imperfect criterion of judgments point is illustrated in Figure 5.6.



(5) Equilibrium point

Based on an imperfect criterion of judgments point, an equilibrium volume is set to 1216. In order to ensure these dealings, 1216 or more demand and 1216 or more supplies should be secured. In order for demand to be certain to exist at 1216 or more, the price should be 78.96 or less. In order for supply to exist at 1216 or more, the price should be 78 or more. When a price is 78.96, the conditions described above are fulfilled, but two sellers who set up the almost same price level (79) as an equilibrium price will say that they were not able to sell water with few differences (refer to Figure 5.6). As for an equilibrium price, in order to reduce this dissatisfaction it is desirable to become smaller than 78.96. Therefore, the

equilibrium price should be between 78 and 78.96 and is set to 78.48 ($= (78+78.96)/2$).

In the case of the example of Table 5.6, an equilibrium point is decided as equilibrium price = 78.48 and equilibrium volume = 1216.

This example explains the actual result of the water market in zone 1A on 6 May 2010. (For the participants in the Watermove dealings on 6 May 2010 there were 47 sellers and 35 buyers. One seller became the target of the first exclusion and 17 sellers and 25 buyers became the targets of the second exclusion. One seller became the target of the third exclusion and 26.8ml of this seller's order was reduced).

Thus pricing of an actual water market is characterised by a complex set of variables (like a craftsman's art) rather than through mechanically applying a minimisation principle. And the consideration that is going to heighten the appeal of a water market functions there.

Chapter 6

Water Entitlements Reform

Section 1: Structure of Australia's water reform

Water trading (also called water markets) is a new method of water resources management that redistributes rare water resources in an efficient way and, through that, contributes to the sustainable development of an economic society.

The special features of water management by water trading in comparison with older water management systems are:

After imposing an upper limit (usually called a 'cap') on the amount of supply (or discharge) of water, public regulation and intervention are reduced as much as possible (based on the principle of private autonomy with incentives) to clear the way for demand management.

By building an unclosed water management system by individual negotiation with the river authorities (government) and a more open and fair water management system (i.e. the water market), it involves many participants and includes the view that efficient allocation of water resources can be realised by a **'free competition principle'**.

In other words, the founding of a water market converts the water management approach monopolised by the government as a public domain to a private domain of capitalist economy.

In explaining the global image of Australian water reform, we would like to clarify the position of the water entitlement reform in this section.

We will start by defining **water reform**. Water reform is a general term for many reforms which are needed in order to found the water market described above and to fix it. Of course, water reform includes a water market reform as the core. The remaining components are political, administrative, legal aspects related to water market reform, and environmental policy reform. When looking at water reform as part of public sector reform (or both overlap mutually), the privatisation and corporatisation of the water industry is contained in the view of water reform. Furthermore, the support many residents and communities are involved in also constitutes a part of water reform in a broad sense.

Water market reform is the founding and developing of a water market directly, fixing it as an efficient system for reallocation of water resources and making it functional. Australian water reform started as water market reform in the 1980s. When it was established and expanded, it turned into water reform in conjunction with administrative, organisational or political reform in the 1990s, and it can be concluded that water market reform came to be positioned as the main component after 1990s (refer to Figure 6.1).

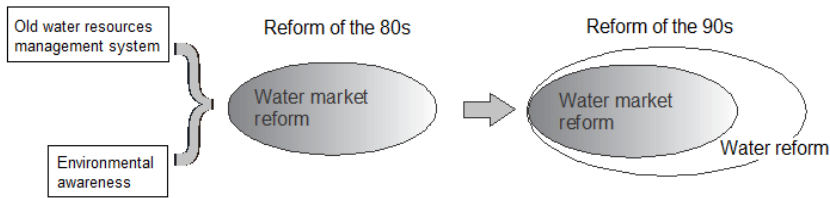


Figure 6.1: water reform and water market reform

Water reform has three subsystems, although it has one settlement as a whole. The first is making water rights tradable. Specifically, this process is required to define water rights as a new right of private property apart from land title, and also establish a recording system etc. We will call this process **water entitlements reform**.

The second subsystem is the creation of an efficient water market and operating it. By ensuring transparency of information, minimising transaction and delivery costs, constructing a free, fair and competitive water market, and an efficient redistribution system of water resources including a measurement system must be designed and built and fostered. However, for the founding of an efficient water market, various preconditions are required. One is management reform of water supply organisations. We will call this portion **water industry reform**. The second precondition is the development of a water pricing policy. This is because, previously, the water supply organisation was a local monopoly and has set the water price at a low price for higher economic growth. We call this portion

water pricing reform. The third precondition is the creation of the water market itself, such as **creation of the internet water market.**

The third subsystem must coexist with an environmental target and correspond to externality. In order to stop environmental destruction accompanying the development of water markets, since water resources are directly connected with the sustainability of an ecosystem, the mechanism in which the development of a water market and environmental preservation are compatible must be considered, and a **new environment policy** must be developed. Therefore, the global image of water market reform became as shown in Figure 6.2.

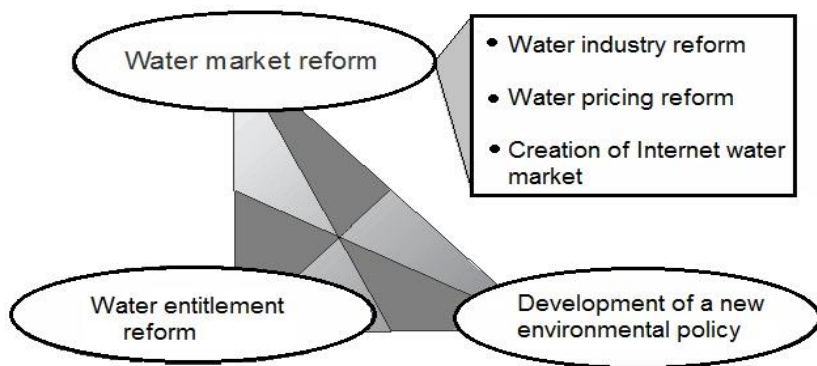


Figure 6.2: three components of water reform and preconditions for water market reform

Furthermore, water reform not only includes water market reform, but makes the participation and support of irrigation farms, companies, environmental managers, environmental organisations, local self-governing bodies and the like indispensable. Without the support of an extensive community or public, water reform is hard to maintain – and people's support is not obtained by injecting immense treasury funds. In that sense, water reform includes positive support and participation at the community level. That is, the global image of Australian water reform consists of the following three layers.

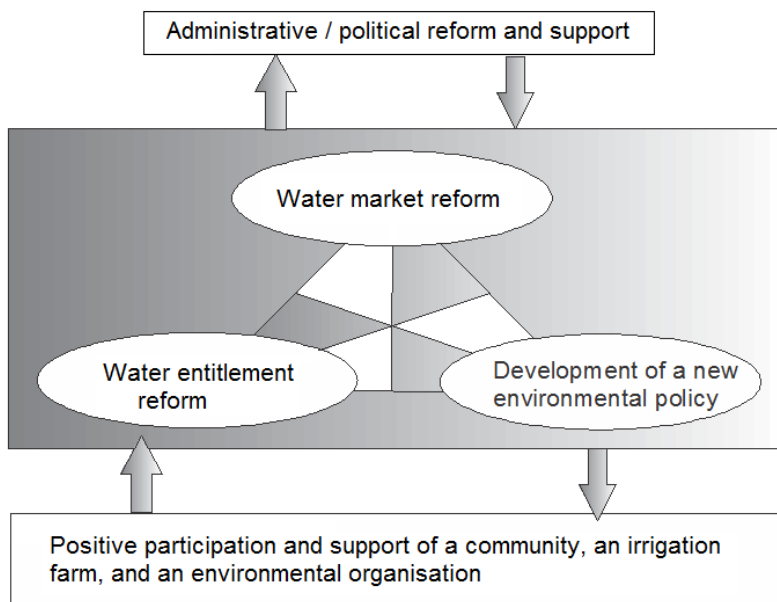


Figure 6.3: the global image of Australian water reform in a broad sense

Based on such an understanding of Australian water reform, we will clarify the central subject of this chapter as the examination of water entitlements reform. Especially, we would like to focus on the establishment of water entitlements as a new right of private property distinct from land. And we will examine other legal subjects from the viewpoint of construction of an efficient water market.

Examination of the other aspects of water reform is left to other chapters.

Section 2: Four subjects of water entitlement reform

This section examines what kind of water entitlements reform is needed in order to build an effective water market.

Water rights can be defined as the exclusive possessory rights to river water (or groundwater) for the time being. In Phillip Fox's report, it is defined as follows:

“Water rights have traditionally been rights to take, use or receive water. In almost all cases their exercise involves the construction and use of infrastructure” (Phillip Fox, 2004, p.3).

In order to realise this, a fixed water supply institution and infrastructure and a control mechanism must exist as a natural premise. Then, we assume that dams, floodgates, waterways, pipelines, water intake facilities, water-usage measuring

instruments etc. exist, as well as a suitable executive organisation.

Furthermore, the following conditions are required.

6.2.1 First Condition – usufructuary right and licence system

The first condition is that exclusive possessory water rights are established by state monopoly of the right of river management, and the founding of a water intake permission system (licence system). For example, under the River Law of Japan, river water is a public good and, being an object of public management, private persons must not touch a hand to river water in the specified water area, and no river operation and maintenance facilities can be built without the permission of a river administrator (River Law articles 2, 9 and 10). Further, although ‘the running water of a river cannot be the target of private right’ (Clause 2 of Article 2), private persons can occupy and use running water if the permission of a river administrator, i.e. the Minister of Land, Infrastructure and Transport, or the prefectural governor, is obtained (Article 23). That is, by obtaining a water intake licence from a river administrator, it becomes possible for a private person to occupy river water privately. This is not water rights as ownership (or property) that can be dealt in, but water rights as private ‘occupation’ rights

based on a licence system. We will take water rights in this meaning as ‘a usufructuary right’, referred to as water rights.

Thus the first condition and starting point for realising a water market is to establish the water rights as a usufructuary right.

6.2.2 Second Condition – transferable water rights

Separation of ‘take-and-use’ licences and pure water rights (quantity of water intake) is required for the second condition. To transfer water rights there needs to be actual separation of the various use terms of the licence and the quantity of water intake accompanying land ownership. For example, naturally in the use terms of the licence, the concrete terms of the licence for water use: the time period, what amount of water to take, by what kind of method, for what kind of purpose, are defined in which river. (In Japan this is laid out in the Water Supply Use Rule.) Moreover, the right to discharge the drainage accompanying use should also be contained. If various use terms of the licence connected with the quantity of water intake and such fixed land do not dissociate, the free transfer water by dealing becomes impossible.

On the other hand, if looked at from the position of the local community, if the natural/social situation of the area is disregarded and water is taken freely or superfluous water is

freely carried in from the outside, the community will be troubled. So it is necessary to separate the transfer of the water rights as a right of water itself, and the take-and-use terms of the licence, and to manage dealings of actual water separately. And it is necessary to separate legally the portion applicable to ‘water’, and the portion of ‘the conditions about the other water use connected with land’ out of a take-and-use permission (licence) for that purpose, and to define each as a separate entity.

To put it simply, ‘separation of the right of land and water’ (or water rights if accepted as a right different from land) is needed. Existence of water rights as a right of private property that can be dealt in will not be attained without separation of these water rights from the land. We will label the water rights in such instances as water entitlements. The Productivity Commission (PC) report explains the meaning of separation of water rights (water entitlements) as follows:

Unbundling water entitlements [water rights] from water-use approvals means that proposed trades in water entitlements may be approved more rapidly because the agency approving trades would not need to consider the impacts of using that water on the buyer’s land. This means, for example, that once an irrigator holds a licence to use water, water can be purchased without the need for further approval. It also means that a water-use licence holder can sell a part, or all, of their water entitlement and use approval to

perform their specific task without being tied to one another, and provides greater opportunity to trade entitlements and lower transaction costs with commensurate efficiency benefits (PC, 2006, p.44).

In Australia, every state has its own managerial system for the environmental management of land or area. This is a multilayered environment management system called Catchment Management Authorities (CMAs). In addition, in Australia, the water rights separated from land are called **water entitlement**. And take-and-use terms of the licence other than water connected with land are called 'Site-Use Approval', 'Site-Use Licence', 'Water-Use Approval' etc., and are distinguished from water entitlement (refer to below-mentioned Water-Use Licence or Water-Use Approval). Such separation of the right of land and water was prepared over nearly 100 years in Australia and it was eventually realised from the end of the 1980s to the beginning of the 2000s in each state.

In short, the second condition for operating water rights dealings efficiently is to divide the water rights as an usufructuary right into 'Water Entitlement' and '**Water-Use Approval**' legally (refer to Figure 6.4).

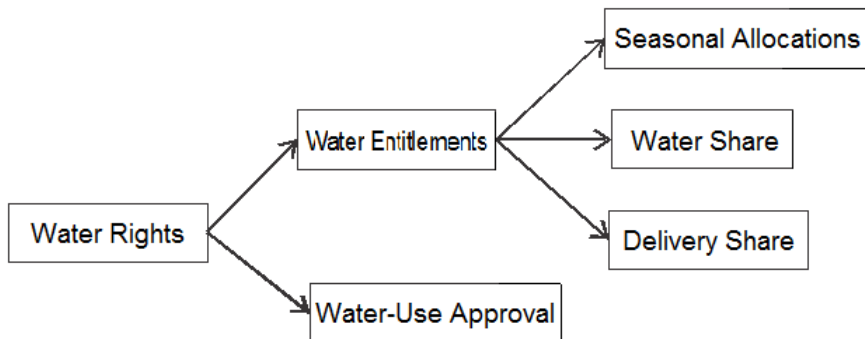


Figure 6.4: water entitlement reform

6.2.3 Third Condition – water entitlement as a private property

The third condition is establishing water entitlement as new ownership. In order to be established as something that can be dealt with in water rights, the separation of land and water rights is insufficient and must possess the legal character as a right of private property. Specifically, it needs to fulfil conditions such as clarification of quantitative nature, reduction of uncertainty, owner's identification, registration of ownership (it is necessary to announce publicly the existence of a mortgage, a co-owner's share and a movement of right, inheritance, the loan of a right etcetera to a third party), and the establishment of the settlement-of-accounts system accompanying dealing etc.

This supplements water's quantitative ambiguity and uncertainty as goods. What is sold at market must have be attributable as goods. For goods to be a private subject, they

must have a certain use value and, specifically, be able to be ruled over clearly and quantitatively. However, since water rights are the rights to take and use water exclusively from a specific source, the right to receive distribution of water, and the right to the share of the water of a source, it is not water itself strictly.¹

For example, when there is no water in a river due to a drought, water will not be obtained even if water rights are possessed, or when an intake facility becomes old and breaks and makes it impossible to use water. Water right is uncertain goods that cannot fully guarantee the quantitative decision that goods should essentially have (refer to the argument on 4.5.6).

In order to avoid such confusion it is necessary to distinguish notionally between water entitlements as a right and the amount of water actually distributed. Then the former is called water entitlement or water access entitlement (in the state of Victoria, water entitlement is referred to as **water share** in 2007 and afterwards) and the latter is called **allocations** or **seasonal allocations**.

¹ Phillip Fox has defined this point as: ‘Although the supply of water is a service that is provided, what is being traded is not a good such as water. What is being traded is a water right that exists only as a fiction of the law’ – Phillip Fox, 2004, p.2.

Moreover, water entitlement as goods also has the uncertainty of another meaning. Even if fixed water rights tend to be acquired and will take in a specific area using a specific intake facility, when the groundwater level goes up and there is damage from salt water, for example due to the increase in drainage by intake water beyond this, a state government may not permit the actual object for water supplies. (Under the present circumstances, all water rights dealings require the formal permission of a state government). Restrictions may be added to the amount of water intake by change of government policy. (This is called **sovereign risk**).

The water rights acquired in such a case may be unable to stop at a mere right and may actually be unable to use water. In Australia, in order to avoid such a problem, special water brokers exist and detailed programs that incorporate the drainage conditions of the area etc. are developed to provide information on whether water rights dealings actually lead to the acquisition of water. Moreover, in each state, class divisions of the practical availability of water is carried out and there is also one state (the state of Victoria, discussed later) that distinguishes between the priority and the price as high reliability water, low reliability water etc. Furthermore, in order to cope with uncertainties such as price fluctuation, new risk management

techniques such as option transactions and forward contracts are also examined.

6.2.4 Fourth Condition – coexistence with the environment

The fourth condition concerns the coexistence of water markets and environmental management. The biggest restriction to the Australian water market from now on is probably coexistence with the environment. A water market has a relationship with environmental issues on the following points:

- maintenance of stream flows for ensuring sustainability of aquatic ecosystems and other in-stream values including water-related recreation
- use of dilution flows for enhancement of water quality
- management of water pollution through a system of tradable emission rights for discharge of irrigation drainage water
- management of groundwater resources in conjunctive use with surface water allocations
- in areas subject to waterlogging and salinity, management of depth to the water table (Pigram, 2006, p.76).

In Australia, it is the state governments that bear the responsibility for environmental preservation and economic development. The following two points lead to restrictions of a water use licence from an environmental side: compatibility with the water distribution plan as the whole containing the water for environment (or the water resources management plan in water management areas), and observance of the water use rules.

For example, the **water resources management plan** supposes the following points should be included:

- state the maximum share of water that is available for consumptive purposes in the water management area
- state the minimum share of water that is available for environmental purposes in the water management area
- state the rules for granting a water resource title in a water management area
- state the rules for transferring a water resource title in a water management area
- state the rules for granting a water operations licence in a water management area
- state the rules for transferring a water operations licence in a water management area (Phillip Fox, 2004, p.8).

Moreover, there is also an area that performs detailed management of dividing the area into some zone(s) and permitting water dealings only between specified zone(s) etc. (Zoning is developed in the southern Murray-Darling Basin).

Next, the state government can define the following rules about water operations:

- how physical access to the water resource is obtained
- how the water is extracted
- by what means the water is received
- when the water may be taken or received
- how the quantity of water taken or received is monitored
- how the quality of water taken or received is monitored
- for what purpose the water may be used
- the operation and maintenance of infrastructure
- the conditions for the supply or receipt of water
- the basis according to which charges for supply are made
- how water is conveyed from one location to another if the water operations licence permits its transfer
- how environmental water requirements are met (Phillip Fox, 2004, p.8).

In addition, water trading and markets need coexistence between the various administrative plans and regulations added from

necessity for such an area and the necessity for environmental preservation.

As mentioned above, there are four legal aspects of water entitlements reform.

Section 3: Historical background of separation of water rights from land titles: The first reform

‘The most important reform to date to simplify and facilitate water trading has been the unbundling (separating) of water entitlements from land titles’ (PC, 2006, p.44). This section will focus on the historical background of this problem.

From the first colonising of Australia until the middle of the 19th century, water rights were considered to be a usufructuary right attached to land, according to the view of the common law of England (refer to Phillip Fox, 2004, Chapter 2). The riparian right (or riparian doctrine) assumed used water was returned to the river without changing quantity and quality, and a downstream person’s right was based on an optimistic assumption that it would not be spoiled and that management of water had been performed upstream. However, in Australia, when much water was taken by evaporation and use of consumptive water increased due to the development of irrigation agriculture, it became clear that it did not suit the actual conditions of such common law. Prime Minister Alfred

Deakin tried to find a water management system that would fit Australia (Pigram, 2006, p.44). He studied the water management system of the western United States and did not introduce a water management system based on an individual rule in accordance with common law, but considered the composition of the water management system from a national viewpoint.

Namely, all the water resources are first declared to be possession of the Crown, and a state government (with a minister specialising in water) executes management of the resources by proxy. Furthermore, the minister's power was transferred to an authority (an irrigation trust at that time) and it conceived a hybrid system that unified state control and citizen autonomy with this authority managing water resources in a fundamentally decentralised way.

The state of Victoria's Irrigation Act of 1886 showed this view explicitly. Here, it was declared that all running water was public property. And although not each landowner (persons other than the landowner with riparian rights were also covered) could own water, the authorities' permission (annual permits at that time) should be obtained and water should be exclusively used (occupied) for irrigation or commercial purposes. That is, water rights as a usufructuary right was established in this Act.²

² Large-scale irrigation had its origins in Victoria in the irrigation trusts that sprang up after the 1877–81 drought. The Irrigation Act 1886 supported these trusts with government loans for developing distribution works and assigned

The Victoria government has expressed the meaning of the Irrigation Act 1886 as follows:

The intention of this Act was to replace common law riparian rights with statutory rights because common law only allowed people to use water for domestic and stock use. The Irrigation Act 1886 allowed Victorians to apply for annual permits for irrigation and other purposes. The permit holder was entitled to take water for irrigation or commercial use, but was bound by an overriding responsibility to let the stream flow on (Victorian Government, Stream Flow Management Plan, accessed 27 November 2012).

In this way, Australian water resources management will be fundamentally left in the defined public managerial system. However, the remaining individual portion of common law will be survived as domestic and stock right.

After the Meiji Restoration, although the view of the present River Law of Japan to monopoly of the river right of management by the central government was similar to the Australian view of public management, since ‘modernisation from the top’ was performed quickly, regulation by law or a citizen’s participation was not enough and it did not realise the decentralised managerial system.

	England	Australia	Japan
Who is the owner of river water?	<ul style="list-style-type: none"> • Water is a shared resource of a community. 	<ul style="list-style-type: none"> • Water is a shared resource of a community. However, European migration people's community has strong exclusivity. 	<ul style="list-style-type: none"> • Water is a shared resource of a community.
Character of river right of management	<ul style="list-style-type: none"> • The usufructuary right of water is protected as a right (riparian right) of the individual of the landowner who adjoins a river. (common law) 	<ul style="list-style-type: none"> • River right of management belongs to a state government. (<i>Irrigation Act 1886</i> (Vic.)) 	<ul style="list-style-type: none"> • The joint ownership of water by a traditional community is continued as habitual water rights. <ul style="list-style-type: none"> • The central government monopolises the right of management of the water area specified by the central government. (<i>River Law 1896</i>)
Character of the water as goods	Pure public goods (Water fully exists and the used water is again returned to a river.)	Close to private goods with strong exclusivity and strong competitiveness. (There is stronger competitiveness because of evaporation or irrigation use. Moreover, since water resources are rare, there is strong exclusivity.)	Quasi-public goods with weak exclusivity and strong competitiveness (Since rice production is water intensive, there is strong competitiveness. Since water resources are abundant, exclusivity is weak.)

The administration system for management	Civil self-government	The hybrid of state control and civil self-government	Centralised system
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Table 6.1: comparison of river management in the 19th century

(Source based on Phillips Fox, 2004, Part 2 and Kondo, 2010)

At the turn of the 20th century, water demand grew with the increase in population and economic growth and one huge dam after another was built due to the development of civil engineering. For example, upstream of the River Murray, the Hume Dam (3.030 million ml; 1936 completion) and the Snowy Mountains Scheme (started in 1949 and completed in 1974) were constructed. Upstream of the Goulburn River and Mitta Mitta River in northern Victoria, the Eildon Dam (3.39 million ml, 1956 completion) and Dartmouth Dam (3.9 million ml, 1979 completion) were also built.

As a result, a new legal framework was needed.

In the state of Victoria, the Water Act 1905 inherited the Irrigation Act 1886, and then the Water Act 1958 inherited the Water Act 1905. Under the Water Act 1958 the Governor in Council, on behalf of the Crown, issued fifteen-year licences on the larger regulated and other more highly reliable unregulated rivers. The State Rivers and Water Supply Commission

(SRWSC) issued annual permits on the less reliable unregulated rivers and streams (Victorian Government, Stream Flow Management Plan, accessed 27 November 2012).

Moreover, while economic growth continued, examination of the regulations on groundwater occurred at the beginning of the 1960s. In the early 1960s the government established the State Development Committee on the Underground Water resources of Victoria to review the use and management of groundwater in Victoria. Following the committee's recommendations, the government introduced the Groundwater Act 1969 which allowed groundwater conservation areas to be declared that capped extraction from groundwater systems and allowed licences to be amended to comply with the caps (Victorian Government, Stream Flow Management Plan, accessed 27 November 2012).

By the end of the 1970s the era of large-scale construction was coming to an end. The economic and environmental limits to exploitation were being reached and the emphasis was shifting to making best use of what water was already available (DNRE, 2001a, p.7) .

The 1980s became a time of big conversion of Australian water methods, or water administration. Pigram writes as follows:

It is only since the 1980s that attitudes to water conservation in Australia have changed substantially and serious environmental questions have been asked about any further large-scale intervention in the hydrological cycle. Water resources management is no longer seen merely in terms of storing water and regulating streams for consumptive use, but also as a means of conserving unregulated streams in an unmodified environment for nature preservation and outdoor recreation. Future emphasis is clearly on the efficient management of currently developed water supplies within an overall resource planning framework and the emergence of appropriate legal and institutional frameworks to facilitate improved allocation and use of the nation's water (Pigram, 2006, p.41).

During the mid-1980s, a review and investigation of Victoria's water law commenced. The investigation highlighted the need for a complete overhaul of legislation related to water resource management. Public consultation on the review began in 1986 with the release of the Water Law Review Discussion Paper. In the end, the Water Act 1989 consolidated a number of Acts into one comprehensive piece of legislation. The Groundwater Act 1969 and the Water Act 1958 were repealed.

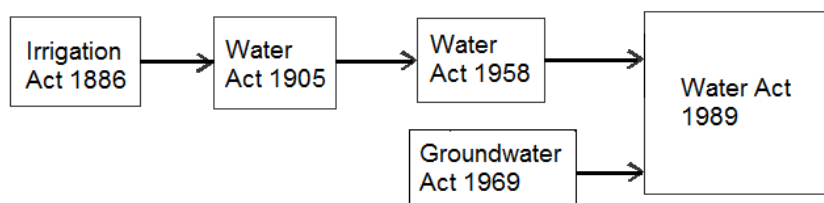


Figure 6.5: flow chart of Water Act 1989 reform in Victoria

And so the epoch-making Water Act 1989 was introduced about 100 years after the Irrigation Act 1886 in Victoria.

Section 4: Creation of water entitlements: the second reform

In order to accept water rights as an independent right to separate it from land ownership and to manage it, construction of a managerial system of water rights equal to land ownership is needed. If seen from such a viewpoint, we may say that the water entitlements reform in the state of Victoria in 1989 made the legal system of Australia conscious for the first time of the commercialisation of water, which is equal to commercialisation of land, for water rights dealings.³

Although it seems that private water dealings were already conducted in Victoria at the time of the drought of the 1940s, temporary trading was officially accepted by legal revision of the Water Act 1958 in August 1987.⁴

³ In South Australia, legal revision that accepted both temporary trading and permanent trading had already been enacted in 1983.

⁴ For the first seven seasons the volumes traded were a modest 25,000 megalitres or so a year, which was less than 1 per cent of the total use by farmers. DNRE, 2001a, p.7.

On the other hand, it seems that examination of the legal revision needed to introduce permanent trading was a little overdue and did not start until around 1984.

A 1984 study made the case for ‘transferable water entitlements’: to let water move to more productive enterprises such as dairying, expose the value of water thereby improving its use, allow individual farmers to adjust their supplies, and provide compensation to those in salinised areas (DNRE, 2001a, p.7).

Moreover, the auction of surplus water that arose from the construction of the Dartmouth Dam was carried out for the first time in Australia in 1988 and established the foundation of acceptable dealing of water (DNRE, 2001a, p.8).

In reactions to the Bill in 1989, there were some who were anxious about water being taken from communities and although leaders of the Labor Party opposed it, noting that it was privatisation, the Bill was eventually enacted by the Cain Labor government in December 1989.

The Victorian Government stated that this Act provides for:

- permanent transfer of water rights and of licence;
- properly specified bulk entitlements (BEs), tradable between authorities;

- environment able to be a legitimate holder of BEs (DNRE, 2001a, p.99).

In this way, the Water Act of 1989 opened the way for environmental water to be safeguarded and for consumptive rights to be clearly defined, as well as for water to be reallocated via the market (DNRE, 2001a, p.8). The Water (Permanent Transfer of Water Rights) Regulations 1991 that defined the rules for enforcement of the Water Act 1989 were issued at the end of 1991 and permanent water trading was carried out from December 1991. Here, bulk entitlement is the big water entitlement granted not to the final user of water but to the water supply organisation authorities (holders of water licences) responsible for distributing water. In addition, irrigation organisations, water corporations, city water suppliers, companies (electric power companies included) with take-and-use licences, and individuals, the minister responsible for environmental preservation etc are all included as authorities holding bulk entitlement (Water Act 1989, Section 34).

It is assumed that areas declared by the minister to be water supply protection areas should be managed by containing environmental preservation within the detailed water resources administrative plan.

Now, we will return to our problem.

How did the Water Act 1989 introduce water rights separated from land into the actual world? (Under the Water Act 1989, the terms ‘water licence’ and ‘water right’ were used in 1989).

‘Water licence’ is the water rights of the authority and ‘water right’ is the individual water rights of irrigation farms. The Act specifies that all water trading needs a Minister’s (or those who inherited the authority) permission and the minister transfers this power to the authority. The authority is also a bulk entitlements holder and a holder of a take-and-use licence. Bulk entitlement is a powerful legal device as follows.

Bulk entitlement order will:

- enable water authorities to plan for the future with far greater clarity and certainty;
- explicitly define and protect the volume and security of irrigators’ water rights and licences with the associated sales water;
- protect the rights of all stakeholders, including the environment, to water in a clear and unambiguous way;
- clearly establish financial obligations between water authorities and headworks operators and water resource managers; and

- provide a framework for the future allocation of water through trading (DCNR, 1995, p.i).

The Water Act 1989 declared that permanent trading (temporary trading is also included) between bulk entitlements holders was lawful and also enacted (as in the following paragraph) the power to convert a take-and-use licence into individual water rights (water entitlements) in the irrigation authority that is a bulk entitlements holder.

Section 62: A licence may be transferred to another person, temporary or permanently. Approval is needed from the Minister – or the rural water authority to which this function has been delegated. A licence may be transferred into an irrigation district, and then application can be made under s.226A to the relevant Authority for conversion of the licence into a water right (DNRE, 2001a, p.102).

In this way, the irrigation authority founded and distributed water rights (i.e. water entitlements) to each irrigation farmhouse via a powerful device of bulk entitlement. This created the water entitlements which an individual can own and each irrigation farm gained water entitlements as private

ownership. And when an irrigation farmhouse wanted to deal in their water entitlements individually, business contacts needed to be found and permission needed to be obtained from the bulk entitlements holder for both seller and buyer.

Furthermore, it was presupposed that the following conditions also had to be fulfilled in that case.

ss.226: Water rights – permanent: The owner of a holding in certain irrigation districts may permanently transfer water rights attached to that holding, to the seller's Authority or to the owner or occupier of any land (i.e. in or outside an irrigation district). A transfer requires the approval of both the seller's and the buyer's Authority (if they are separate); also the written consent of anyone having a prescribed interest (e.g. a mortgagee), with a notice being placed in a local paper at least 28 days prior to the application being made. Appeals against an Authority's decision can be made to the Victorian Civil and Administrative Tribunal (DNRE, 2001a, p.103).

ss. 228: The Governor in Council may make regulations prescribing districts within and out of which transfers may take place, setting limits of trade into and out of areas having regard to existing users and the environment, setting maximum and minimum entitlements to be held, and establishing procedures and fees (DNRE, 2001a, p.103).

Thus, the first permanent trading eliminated participants other than farmers and was limited to dealings between landowners. Although water rights were accepted as a right independent of land, in actuality the dealings were limited to dealings between land ownership and the idea of today's open and free market was far away.

However, after passing through various experiences of pilot interstate trading, the water rights that can be dealt in are defined by law, backed by the federal government. Now, a non-farmer and an individual can own in all the states of Australia and territories. In addition, as for the present Water Act of the state of Victoria, various amendments were added in 1989 and afterwards. For example, the term 'water rights' used in the Water Act 1989 has been changed to 'water share' from 2007.

	Volumetric or Share	Security	Separation from land	Individual Carryover	Governing legislation
NSW	Share	General (55%) High (95-97%)	Separated from land	Allowed	Water Management Act 2000
Vic	Volumetric	High (96-99%) Sales water (45-75%)	Being separated from land	*Not allowed	Water Act 1989
Qld	Volumetric	Medium or High	Being Separated from land	Depends on water sharing rules	Water Act 2000, Water Regulation 2002
WA	Volumetric	Various levels of security	Separated from land	Not allowed	Rights in Water and Irrigation Act 1914

SA	Volumetric	High (almost 100%)	Being separated from land	Not allowed	Natural Resources Management Act 2004
Tas.	Volumetric	80%	Separated from land	Not allowed	Water Management Act 1999
NT	Volumetric	High	Separated from land	Not allowed	Northern Territory Water Act 2004

**Table 6.2: the legal basis of water trading in
each state of Australia as of 2006**

(Source: PC, 2006, p.274.

**Note: *in the state of Victoria, the carryover
system was introduced from 2012)**

Permanent trading and temporary trading in Victoria from 1990/01 to 2000/01 were shown in Figure 1.3 of Chapter 1.

Section 5: Unbundling of water entitlements; the third and fourth reform

The 1990s were a time when the global environmental problem attracted major interest and various reforms materialised about the management of natural resources. Although the details are omitted here (see Section 2 of Chapter 1), Australian water resources management underwent a fundamental change of state policy and saw the establishment of the law on natural-resources

management while reform of the Victorian Water Act 1989 led the principle of ecologically sustainable development. This was accompanied by changes in the use of market mechanisms to reform water administration, streamlining of water supply organisations, including corporatisation and privatisation, and reform of water prices and natural-resources management. Meanwhile, the unbundling of water rights had important implications for the development and construction of an efficient water market. Here, this problem is examined.

6.5.1 Maximum Limit and Flow Management System for Water Supplies

First, we should think: how can water be bought and sold from A to B?

When transferring a fixed amount of water from Mr A to Mr B, noting that the problem of the uncertainty of delivery infrastructure or precipitation exists, I will think of how execution of the dealings is attained.

Water services become helpful. The water service can use water if a tap is turned and the amount used is measured individually. Therefore, when water-use facilities always exist between Mr A and Mr B, and measuring instruments are installed in each, and the amount used by Mr A and Mr B is managed, Mr A gives up the use of 1ml of water, and the

movement of 1ml of water from Mr A to Mr B is attained because Mr B actually uses 1ml of water. Mr B pays money to Mr A at the counter value, and water rights dealings will be completed (in the case of temporary trading).

Next, the problem which should be considered is to determine the maximum amount of use of the total user containing Mr A and Mr B from the environment.

Here, one valley is considered. There is rain and we will suppose that there are water-storages such as dams, rivers, intake facilities and water supply network institutions. Precipitation of the whole valley is set to R every year. And supposing only ξ ($0 < \xi < 1$) of precipitation is able to flow into a dam, the amount of water that can be used will serve as $\xi \cdot R$. We presuppose the dam is stabilised in a river and running water of H cubic metres/second can be poured. A relationship between the water H that flowed out of the sluice gate of the dam and dam pondage is $\int_{t_0}^{t_1} H dt = \xi \cdot R$. Here $[t_0, t_1]$ will consider one year during the period.

Now, when defining the amount of water rights under such a setup, there may be two kinds of methods of setting to a flow and water stored in a dam. Setting the amount of water rights to a flow is the method of setting Mr A's amount of water rights to x_a cubic meter/s. Since this must serve as $\sum x_a \leq H$, it will draw

the maximum of water rights that can be distributed the size of H . The upper limit Ha of Mr A's water use serves as

$$\int_{t_0}^{t_1} x_a \cdot dt \leq Ha \leq \sum H_i = H. \text{ Therefore, the water rights defined by}$$

the flow will define water rights to the running water of a river.

Because only management of a river flow rate is needed, this method is comparatively easy to manage without needing the construction of a wide range of water supply institutions. But there are downsides and futility (opportunity cost is large). For example, even if it does not actually intake water from a river, additional expense does not start, but if Mr A does not use water, the profits which other persons were probably able to use will be sacrificed. Moreover, dividing is not easy even if Mr A tries to sell his water rights. Such a situation will become a factor that makes conducting water rights dealings difficult. Typical flow-type amount of water management is a system used in Japan.

The definition method of another amount of water rights is a method of setting water rights to water $\xi \cdot R$ of a dam. It is the method of management that this stores water to a dam when Mr A does not use it, and it supplies water to Mr A's basis in water when Mr A uses it. This method needs large-scale water supply equipment and fine management. If Mr A's water rights are set to Ea , the maximum of the water rights in this case will serve as $\sum Ea \leq \xi \cdot R$.

Since water remains if Mr A does not use water rights, dealing is easy. Typical stock type amount of water management is a system used in Australia.

The latter system is fundamentally important for the development of a water market. The amount of water rights defined below in this way will be considered.

The water supply administrator sends the specified amount of water to the sluice gate of Mr B. If it changes into the state where water is always arranged in fact in the waterway with Mr B's sluice gate, even if it does not supply water from a dam specially each time, Mr B can intake water. Mr B pays money into Mr A's account, Mr A and Mr B pay the fee for a water supply service to a water supply contractor, and this ends these dealings.

The amount of water rights and the amount used are recorded on Mr A's water account and decreases by the part sold off to Mr B by these dealings. On the other hand, the amount of the water used increases only by the amount of water rights that Mr B purchased from Mr A. Since Mr A's quantity and measured magnitude of water account are contradictory, supposing he uses the water that he sold off to Mr B, a water supply contractor can check Mr A's violation.

6.5.2 Water Rights and Uncertainty

The next to be considered is correspondence in the case of changing the amount of water in a dam, when dam pondage defines water rights. For example, when pondage halves due to a drought, even if it has water rights of 100ml, the amount of water that can actually be used is 50ml.

In order to correspond to such a change, water rights are literally made into a right and separated from the concrete amount of water. That is, water rights need to be defined as the capacity of a dam instead of the water stored in dam, when the pondage of a dam is 100 per cent, 100 per cent of water rights can be used, but water rights are restricted only to the quantity of water stored in the dam at the time of a drought. In other words, it is necessary to define water rights as the right with uncertain value like a stock. In addition, it is necessary to announce officially what percentage of water of a dam's capacity can be used for a user's facilities.

Then, if Mr A assumes that the water rights of 50ml remain and the pondage of a dam at present becomes 80 per cent, the amount of water which can be used at present is calculable with $50\text{ml} \times 80 \text{ per cent} = 40\text{ml}$, for example. Similarly, the buyer of water rights can calculate how much water can actually be allocated as water rights.

6.5.3 Fee for a Delivery Institution

The following is the problem of charges paid to the administrator of a delivery institution. It is necessary to divide this expense into two steps and to consider each of them. The first step is the problem of cost allocation between the administrator of a dam and a water supply contractor (bulk entitlement holder). The second is the maintenance of the infrastructure by a water supply contractor and the levying of fee. Chapter 8 considers the relation between asset and profit in more detail.

We should distinguish the following three expenses.

- (1) the variable (or operational) cost and expenses
(personnel expenses, electricity cost etc.) for delivery of water;
- (2) the administrative and maintenance expense (fixed cost or overhead cost) of delivery institutions;
- (3) the investment expense in the case of newly performing water supply (financial cost).

For (1), a charge can be set according to the amount of deliveries of water. Since (2) is a fixed cost, the administrative and maintenance expense is needed in order to carry out maintenance management of the institution, even if a user does

not use it. For example, when a water supply institution needs to be updated in 30 years, the renewal expense has to be allocated and saved. Furthermore, when a discontinuance of business occurs within a certain irrigated land division, there is the problem of what we do with this fixed cost burden.⁵

Although withdrawal money called **exit fees** is imposed for a discontinuance of business under the present circumstances, should we calculate a withdrawal rate and should we make the user of water dealings pay? Or should a seceder be made to pay? Furthermore, should an exit fee be imposed on those who sell water rights outside the area?

Supposing, for example, a fixed cost is included in a fee when farms in NSW buy water from farms in Victoria, the NSW farms that do not use the delivery institutions of Victoria at all will say in this case they should pay the Victorian exit fee or the Victorian fixed cost for updating.

Moreover, when the size of the exit fee changes with areas, the area's amount of supply that justified the high charge may decrease and the water supply of the area that imposed the low charge may increase, and it may be contradictory to the water supply structure of the area (PC, 2006, p.288). Water rights should probably be set up so that the constant user of a delivery institution co-owns with the water supply institution, and the fee

⁵ This is called the problem of stranded assets, or the problem of exit fee. Refer to PC, 2006, pp.92–104.

should pay the maintenance renewal expense of the water supply institution as a separate charge in order to solve such inconsistency and problems.

The PC report has described as follows the meaning that separates the delivery right (or delivery share).

- providing utilities with another tool to manage their infrastructure and reduce congestion and associated costs
- providing greater flexibility for owners in selling part of their delivery entitlements – for example, owners may sell part of their delivery entitlement and use their remaining entitlement in ‘non-peak’ times such that their full allocation of water may still be delivered
- improving the reliability of delivery for particular entitlements held (which may be especially helpful for irrigators with water sensitive crops)
- allowing for the removal of some regulatory restrictions on trade that were introduced to manage hydrological constraints related to congestion issues (PC, 2006, p.48).

The example of Victoria’s exit fee is mentioned in 6.5.6.

6.5.4 Coexistence of Water Trading and Environment

Management

Because various conditions, such as ecosystems, geology and the groundwater level differ from area to area when using water, it will be necessary to define the usage rules of water. Approval of trading will take time, supposing parties to a sale check the use rule and accept water trading. Moreover, trading between areas where licence dealings terms differ greatly will become difficult.

Those who buy water need to ensure they comply with the rules applicable to their own areas, and those who sell water do not need to observe the local rules for water use in the area to which a buyer belongs. What is necessary is to make water purchasers observe the use terms of the licence. In this way the licensee who uses water in a specific area can do be brought under a licence system and the environment of the area can be maintained by ensuring licensees follow the rules for use.

As mentioned above, when water rights was actually enabled, it became clear that four important restrictions exist– the water quantity management system, the uncertainty of the amount of water, the problem of the fixed cost burden of distribution equipment and coexistence with environmental regulations.

This is a new problem different from the transfer of the ownership of land.

In solving such problems, Australia found the solutions can be broken down into the following four components:

- (1) Water actually distributed –seasonal allocations
- (2) The right to fill water in the dam water storage spaces – water share
- (3) The right to co-own a water supply institution and to receive water supply service constantly – delivery share
- (4) The right to use water in a fixed area – water-use licence (refer to Figure 6.4).

For example, if an irrigation farm has a licence (4) to use water in a certain area, water (1 and 2) can be dealt in freely. And in getting water to actually supply water to the land (1) used, the right of a water supply institution (3) is held and he pays the fee according to the amount of use.

When this irrigation farm gives up its business, the right of a water supply institution (3) is sold or transferred and its business can be given up by paying an exit fee. That is, the co-owner of the right of a water supply institution pays the renewal expense of a water supply institution and a temporary user pays only a fee. Agriculture can be started with actual water delivered. If farmland is purchased, the licence of (4) is acquired, the right of (2) and (3) is purchased and a water supply fee is paid when

entering newly as an irrigation farmhouse.

The rights (1) and (2) can be freely dealt in regardless of land ownership in a water market.

For details, Victoria's case is introduced (carried out from 1 July 2007).

6.5.5 Water Share

Until now, when river water was taken and used in the state of Victoria there were three legal bases:

- Land ownership (water entitlement owned by irrigation farmers) or a licence (diversion licence owned by water suppliers, companies etc.)
- Domestic and stock allowance
- Temporary purchases in the water market (sales water)

Domestic and stock allowance is a portion of water used for the usual life of farms, including livestock, and the size is customarily accepted as different from water rights (resembling the habitual water rights of Japan).

The Water Act 1989 was converted into the new legal framework unified by the water share in July 2007 and afterwards. In addition, groundwater and the water of waterways

where neither G-MW nor MDBC managed is now excepted from the object of water share.

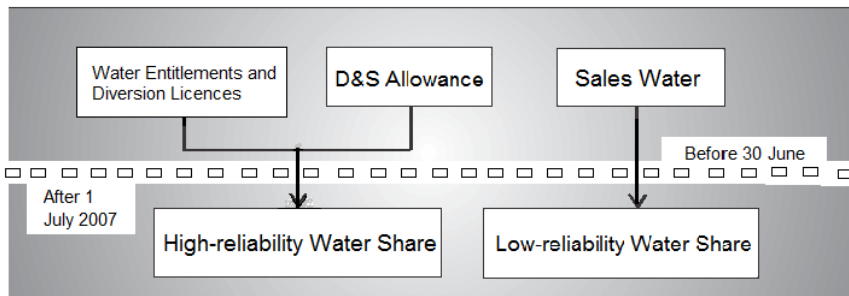


Figure 6.6: water entitlement reform in 2007 in the state of Victoria

That is, the water entitlements of those who are accepted as landowners in the land registration system are automatically changed to water shares.

When changing from a take-and-use licence (diversion licences) to water shares, those who are registered as a licence owner can turn into an owner of water shares from a management organisation.

Furthermore, when introducing this water share, in order to correspond to the uncertainty as goods, the following two kinds of water share were introduced:

- High-reliability water share:

100ml of water entitlements connected with irrigation farmland is converted into 100ml high-reliability water share.

However, when the source water decreases by 50 per cent because of a drought etc, even if it is the high-reliability water share of 100ml, only 50ml of water is distributed.

- Low-reliability water share:

All the water formerly called ‘sales water’, i.e. the water temporarily supplied through the water market, is converted into this type of right which can also be dealt in. The total amount of the new low-reliability water share is published so that the amount of water agrees with the actual amount of the maximum used in abundant years. With this 100ml type of right equity the water that is actually distributed changes with irrigated land regions, rivers and years. For example, in the Goulburn irrigated land division in 2008, they varied from 48ml to 100ml. Similarly, it was 56ml in the Campaspe irrigation division and 0 ml in the Nyah irrigation division.

They are described as ‘water shares’ because they resemble stock shares in that ownership is eternal and they can be dealt in a market, although the value (amount of water and price) fluctuates.

<The **10 per cent rule** about water share>

The ratio of total amount of water share that is not connected with land to total amount of water share of the area has the rule

that 10 per cent must not be exceeded. It is supposed that a water minister sets this rule after hearing the opinion of those in an irrigated land region.

6.5.6 Delivery share

In the fixed irrigated land region where gravity irrigation is performed, **delivery share** gives the right of infrastructure use to irrigation farms. This includes the right that the water flowing through the fixed irrigation institution can be used together, simultaneously. Entitlement of the present 100ml is converted into delivery share of 1 ml/day.⁶ In order to obtain this, payment of the following charges is required:

- (1) Infrastructure access fee (IAF): expenses for building or updating the irrigation institution of the area concerned. It changes with the size of delivery share and needs to be paid every year.
- (2) Infrastructure use fee (IUF): delivery share × A\$270
- (3) Casual infrastructure use fee (CIU): an extra charge in the case of receiving water distribution exceeding the annual delivery allowance (ADA).

In addition, water corporations such as Goulburn-Murray Water

⁶ Note: a current entitlement of 100ml will convert to a 1ml per day delivery share. PC, 2006, p.102.

(G-MW), not joint control by irrigation farms, manage the actual infrastructure.

When it collects, the infrastructure fee paid to G-MW is A\$3000 per 100ml. This charge is a fixed expense irrespective of the amount of water used.

Next, when it becomes unnecessary (for the reasons of discontinuance of business etc) to own a delivery share, it is processed by the following three methods:

- (1) To continue paying only the infrastructure access fee in which case the possibility of resuming as a farmhouse is maintained.
- (2) Transfer all or part of the rights to other irrigation farms.
- (3) Pay the termination fee (or exit fee) and some or all of the delivery shares are sold off and business is given up.

The termination fee (TF) is 15 times the IAF.

IAF, CIU and TF etcetera are used to maintain the infrastructure for water supply services, such as waterways, pipes, natural waterways, measuring instruments and management expenses.

In northern Victoria, it became possible to introduce the delivery share from 1 July 2007 and to conduct water trading more independently as a result. These delivery shares can be tradable only within the user of the same waterway system (refer to Victorian Government DSE, 2008, Draft, p.30).

6.5.7 Water (Site)-Use Approval

The purpose of this approval is to keep the use of water from having a bad influence on others or the environment. For example, when dirty drainage occurs, damage is inflicted on people downstream. If drainage is left uncontrolled, the groundwater level will rise and it cause damage from salt water. Moreover, depending on the intake water, unrecoverable damage is done to wildlife or plants. For this reason, an irrigation farmer has to obtain water use approval from the Minister. Or, according to the standards and rules that were defined, people have to undertake the use and drainage of water.

Although the separation of water rights and land in Victoria was once defined by the Water Act 1989 reform, in actual dealings, this distinction is indistinct and people were not clearly conscious of the difference between water rights and water use permissions for irrigation farms. However, by the introduction of water shares and clarification of delivery shares in July 2007, water entitlements and water-use approval connected with land titles were again clearly separated, and river water and groundwater can now be dealt in freely.

Although water shares move by dealing, water-use approval has adhered to land and does not leave a specific area. Water-use

approval cannot be dealt in and observes the following four standard conditions:

- (1) Maximum of annual use limit (AUL): the maximum amount of water used by each irrigation farm must not exceed the land it manages. The size of AUL is defined on the basis of water share, or historical use and other factors.
- (2) Use water as measured by a defined measuring instrument which records the amount of water used by a previously defined measurement method.
- (3) Duty of suitable liquid waste treatment: water users have to process waste water in line with standard conditions set by the management organisation, and within a required time period.
- (4) When producing rice, separate permission is necessary because of the higher water consumption.

When the Minister for Water changes the conditions of water-use approval, the Minister has to hear an irrigation farm organisation's opinion and the opinion of the catchment management authority (CMA).

Water-use approval is regularly updated although it will not be updated if there is no use record in farmland for ten years.

Paper documents are not required and it is only necessary to register with the electronic water registration system of a state in order to obtain permission.

As contrasted with a water rights system of Japan, I will summarise the result of the above consideration.

	Australia	Japan
Legal basis	Water Act of each state	River Law
Character of water rights 1	Private goods (Individual possession or organisation possession)	Quasi-public goods (organisation possession)
Character of water rights 2	Perfect ownership	Imperfect ownership (occupancy)
Water management system, measurement unit	Stock management system, ML unit base	Flow management system, cubic meters/second unit base
Alienability	possible	possible
Trading possibility	Water Share, Water Allocation and Take-and-use Licence can be traded. However, the Water-Use Approval cannot be dealt in. (In case of Victoria.)	Not possible
Types of water rights	Although there are a right of Domestic and Stock Allowance and a native right, most is managed by the Minister for water resources management of each State.	Two sorts, habitual water rights (what accepted intakes by the Meiji 29 previous social custom), and permission water rights (what a river administrator permits to a user by the River Law).

		Dual management of the Ministry of Agriculture, Forestry, and Fishery and the Ministry of Land, Infrastructure, Transport and Tourism
Range	River water, groundwater, lake water	Only river water (lake water is included)
Permission period	Water Share is eternal. Take-and-use Licence is no more than 15 years. Water-Use Approval is ten years. (In case of Victoria.)	Permission of water rights is ten years in general. Power generation is 30 years. The water for environment is three years (after March 2006). Habitual water rights have no period.
Settlement of mortgage, lease, etc.	available	Not available
Measurement of quantity of water intake	When giving water-use approval, a duty is imposed about measurement. A duty of installation of a measuring instrument is imposed. A water supplier (water corporation or public utilities) performs actual measurement.	Although the applicant is to measure once per year in the case of permission water rights, and to report it to a river administrator, checks by a third party are not performed. A duty for installation of measuring instrument is not imposed.
Water charge	charge	Water for agricultural use will be no charge if infrastructure holding cost is removed.

		(However, the water for irrigation for fields is charged.) Industrial water and the water for city life are charged.
Disappearance of water rights	Water-use approval will disappear, if there is no use track record for ten years.	Permission water rights is extinguished by return. There is no concept of disappearance in habitual water rights.
Separation of water rights and a use permission	It separates into water share and water-use approval.(unbundling)	Unification
Separation with water rights and an irrigation institution royalty	It separates into water share and delivery share.	Unification (However, by the land improvement scheme, central water-use facilities serve as possession of the Governments.)
Separation of environment management and water resources management	The environmental protection system and the system for water supplies dissociate, and have been independent.	Undifferentiated

Table 6.3: Japan-Australia comparison of water rights

(Source: About Australia, created from (1) water-use licences, (2) delivery share and terminal fees, (3) water shares for irrigation district and regulation diversions of unbundling water entitlements – www.gmwwater.com.au, accessed 20 August 2012; About Japan, created from Shimura, 1977 etc)

Section 6: Other legal subjects for water market reform

The August 2006 Productivity Commission report *Rural Water Use and the Environment: The Role of Market Mechanism* analysed and evaluated the present condition of the water market and proposed a required reform. The commission is one of the Treasury's portfolio organisations that make consultation proposals mainly in connection with microeconomic reform. The commission, set up in April 1998, unified three organisations including the Industry Commission. Hereinafter, legal subjects other than the above are introduced simply by referring to this report.

6.6.1 Introduction of Carryover System: Intertemporal Optimisation

The exploitation of water resources requires optimisation not only within one irrigation period but within two or many periods. For example, although the drought was severe and crops were not fully produced this year, a farmer would like to aim at retrieving this year's loss next year.

In this case, the carryover system can offer the means for attaining intertemporal optimisation.

- Carryover water was developed as a product on the basis that it provided a mechanism for irrigators with the capacity to make a decision to plant a reduced crop in low allocation years to carry over water to the subsequent year to enjoy economies of scale in the following year i.e. increase flexibility (Coleambally Irrigation Co-operative, sub. 3, p.39 as quoted in PC, 2006, p.51).
- The main advantages of individual entitlement holders being able to carry over water include improved intertemporal water choices and a better ability to manage the risk associated with changing seasonal conditions (PC, 2006, p.50).

If there is no system of carryover, the use of surplus water will be lost and thrown away into a river. This will also have a big influence on the price formation of water markets, and a water price will be almost worthless at the end of water trading.

Therefore, the introduction of a carryover system is important not only for an irrigation farmer's risk management but also for the price formation of a water market.

However, since various costs, such as the problem of dam capacity, are needed to implement a carryover system, various situations should be examined for its introduction.

Moreover, the confusion or feelings of inequality arising from the different regulations for each state can pose another

problem associated with the introduction of a carryover system. For example, although carryover is permitted in NSW, it is assumed in downstream SA that permission is not granted. When the irrigation farms of SA transfer water rights to farms of NSW, carryover of these water rights becomes possible.

PC describes this problem as follows:

- The difference in a carryover system is reflection of the natural social situation of the water resources of each area, and is rational.
- The farmhouse of NSW which purchases water from SA can have a choice on a new management decision called the purchase of the right of carryover.
- Movement of the water from SA to NSW is desirable on another side, seeing from an economic viewpoint of the optimum allocation of water.

After all, the PC has judged that a special problem does not have these dealings (PC, 2006, p.53). Moreover, the PC said that the carryover system becomes an effective means also for an environmental manager (PC, 2006, p.184).

Carryover has some different approaches. The PC report describes this point as follows:

Some arrangements, for example, are based on a perpetual carryover capacity share approach, while others allow for a certain percentage of an entitlement to be carried over each year (PC, 2006, p.50).

Next, suppose that a certain farm used 100 per cent of its water rights in the area where 15 per cent of carryover is accepted, for example. Since he does not need to use the right of 15 per cent of carryover, he can sell this right. Another farm will be able to exercise 30 per cent in all of carryover for the 15 per cent of right that he has, and the 15 per cent of purchased right for next year. Thus, dealings of carryover rights will also serve as an issue that should be examined from now on. However, for the moment, there is no track record of having actually dealt in the carryover right.

6.6.2 Conversion to Capacity Sharing from Volume Sharing

We have already discussed the rationality of setting up water rights not to the flow of a river but to the pondage of a dam. However, when setting up water rights to dam pondage, a problem arises in the volume sharing method of setting up quantity. For example, both Mr A and Mr B have water rights of 100ml. Mr A needs water at the beginning of an irrigation season and Mr B presupposes that water is required in the

second half. Based on one rain prediction per year, it is predicted in the first half of an irrigation season that water is comparatively abundant throughout this year, and Mr A presupposes that 100ml of water was distributed. However, if precipitation decreases and the water that flows into a dam decreases after that, unfairness arises in which the user of the second half cannot use 100ml of water even though the user in the first half of the season could use 100ml of water.

To cope with such a situation, water rights are redefined as a right holding not the quantity of water but the space that collects water, and also information is released daily about the amount of water that can be used according to the water rights which he holds. The former is called (storage) capacity sharing and the latter is called continuous accounting.

Here, the example of St George in Queensland is explained (PC, 2006, pp.54–59).

Capacity sharing defines entitlements in terms of a share of dam capacity (not contents), and inflows and outflows (which include deductions for evaporation and seepage losses). Therefore, the amount of water to each user's water rights in which actual use is possible is decided by the following formulas.

$$\text{Volume in share} = \text{previous volume} - \text{share of storage losses} - \text{withdrawal} + \text{share of inflows}$$

*Storage loss contains conveyance losses, such as evaporation loss and channel loss.

1. Water available for water users is calculated daily with water accounts provided once a month. Owners, therefore, assess the availability of water themselves at any point, based on the water in the share and their estimation of losses and the likelihood of inflow.
2. Conveyance losses reflect (in part) the location of users and when they wish to extract. However, storage losses (for example, evaporation losses) and channel losses are shared equally between users.
3. Water losses are calculated daily and taken from a user's account, although rates of loss are based on average for each month (so loss rates vary across months but not days).
4. Water is accessible within one day. When ordering water, SunWater checks that sufficient water is available in the account and that it does not exceed the usage limit (or resource cap).
5. Online business transactions, including water trading, were incorporated into the system in 2005.
6. Resource caps apply to the amount available for extraction, set at 100 per cent of the water allocation (entitlement) plus 20 per cent if irrigators have used less than their full

capacity the previous year. This is to manage third-party effects (PC, 2006, p.56).

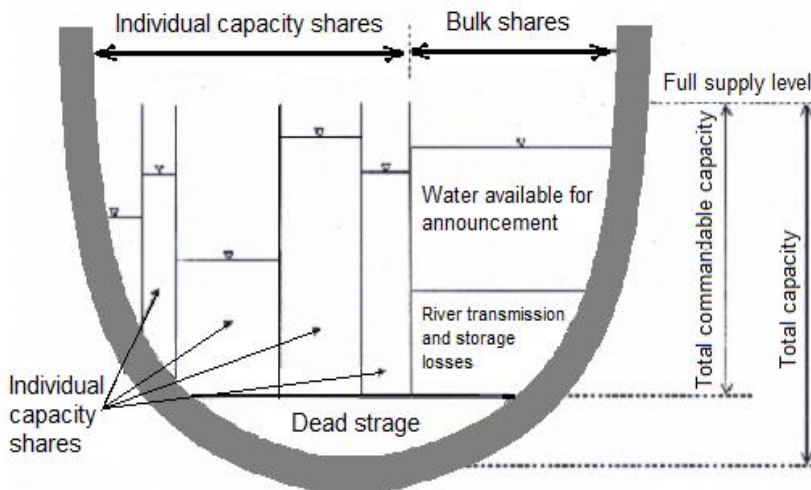


Figure 6.7: conceptualising capacity share

(Source: PC, 2006, p.55, partly modified)

Capacity share needs continuous accounting. The report describes both relations as follows:

- Capacity share arrangements do not have to incorporate continuous accounting, but their complementary is strong for two reasons. First, capacity share arrangements allow irrigators to manage their own water supply decision, and continuous accounting provides information to help irrigators in making these decisions. Second, providing

information on the probabilities of water available to irrigators is easier under a capacity share approach than under volume share because it would not necessary to know all other irrigator's demand over the season (Dudley and Musgrave, 1988 as quoted in PC, 2006, p.56-7).

- Capacity sharing is a water allocation system by which users are allocated a share of the storage as well as inflows, and seepage and evaporation losses. In effect, the storage is partitioned into sub-storages that are credited with a volume of available water according to the hydrological behaviour of the storage and its catchment. Users have non-attenuated rights to this share and can manage its retention or release in a way that does not impact on other water users.
- Capacity sharing is seen to have advantages over the usual method of water allocation following release from storage. By partitioning entitlements to water at source rather than at the point of delivery, the conditions for an efficient water market are satisfied and transaction costs minimised.
- Capacity sharing offers the potential for individual control of the water in sub-storage by irrigators or by community groups acquiring shares for environmental purposes or flood mitigation (Pigram, 2006, p.76).

By introducing capacity sharing and continuous accounting, the reliability of the trading volume, which is fundamental information required for water trading, increases. Moreover, making timely decisions independently without being influenced by others' actions is becoming more and more important for irrigation farmers from the viewpoint not only of development of a water market but also of development of irrigation agriculture (the merit of introduction of these is arranged by PC, 2006, p.57).

A new subject occurs with the problem of extension of the water source that is the target of capacity sharing. Although capacity sharing is designed under the present circumstances for dam water, this view can be logically adapted for other water sources, for example, groundwater. That is, designing capacity sharing on the basis of the annual average amount of groundwater recharged.

Although there are issues that should be examined scientifically, such as the problem of the linkage of dam storage water and groundwater, a change of precipitation is also becoming an issue with important integrative use of groundwater and dam water in Australia. Moreover, if a flood can be stored to groundwater, the possibility could eventuate of using floodwater.

Water resources management including groundwater and

capacity sharing will serve as an important issue for the future in Australia.

6.6.3 Reform of the Titling System of Water Rights and the Register System

When converting water rights into the more secure right of property, or converting it into something that can be dealt in, an input from land dealings is needed, such as data on processing the uncertainty of quantity or value. Also needed is office work to see if there are frequent dealings, and a division of water rights. Furthermore, in order to enable an irrigation farm to invest in response to a loan from a financial institution, it is necessary to examine the setup of a mortgage. Specifically, such various situations are needed to construct suitable titling and register systems.

In Australia, the Torrens system that is used when processing land ownership serves as a base. This system is an indefeasible system which cannot confiscate existing ownership other than the interest recorded on this registration system, and all the information about specific land is recorded. This system provides good security for titleholders and is suitable for dealing or a loan. Moreover, costs are low and proving rights for mortgage setup etc is easy (PC, 2006, p.61).

However, under this system, expenses are high for actions

such as the division of water rights and partial rights dealings. As a result, it is difficult to remove a mortgage. In addition, since fixed water rights (for example, 1ml) do not guarantee use of that quantity, it makes the concept of the same indefeasibility as land difficult to apply.

The PC report describes as follows:

The Australian Property Institute (NSW Division) and Australian Spatial Information Business Association emphasised that the indefeasibility linked with a state guarantee of title does not guarantee the volume of an entitlement but ‘merely provide[s] protection against fraud and other misdealings in water entitlements as is the case in land property’ (sub.DR88, p.13 as quoted in PC, 2006, p.63).

Next, on the water rights recording system, there are differences between each state or irrigated land division in Australia, and there is discussion about whether to centralise and unify this or to leave it to a water management public utility (water utilities).

- Coleambally Irrigation Co-operative (CICL) expressed the view that existing central registers suffered from inherent delays with dealings and high error rates. CICL’s register by way of example facilitates dealings to a timeframe of

48 hours, and since registers are linked to billing, it has a much higher accuracy level (sub. DR64, p.4 as quoted in PC, 2006, p.64).

- Australian Property Institute (NSW Division) and Australian Spatial Information Business Association argue that decentralisation of registers would result in even more complexity and greater difficulty in ascertaining sales data to ensure transparency in valuation (sub. DR88, p.8 as quoted in PC, 2006, p.64).

In its conclusion, which refers also to the Torrens system of land that can be searched online like CHESS, the PC emphasises the necessity to examine original titles and register system, which suits water rights more (PC, 2006, p.64).

6.6.4 Minimising Transaction Costs and the Introduction of Online Trading

Electronic trading systems are well established in many regions. These include Watermove (provided by Goulburn-Murray Water, a government-owned water utility that closed down in August 2012), Waterfind and Waterexchange, which are both privately owned corporations (PC, 2006, p.89). In addition, since 2012 SunWaterOnline has entrusted its business to Waterfind.

These contribute to preserving the transparency of information and minimising transaction costs.

The information provided is summarised below. Further information can be acquired from each broker's webpage.

	Waterexchange (National)	Watermove (Victoria)	Waterfind (National)
Operating inaugural year	1994	2002 (closed down in 2012)	2003
Information provided	-Trading rules and fees -Prices and volumes -Historic trades -Buyer alerts -Net movement of trades over time (by request for non-commercial purposes)	-Trading rules and fees -Prices and volumes -Historic trades -Buyer alerts	-Trading rules and fees Available to registered users: -Prices and volumes -Historic trades -Buyer alerts
Fee charged for trade in seasonal allocations	Seller pays 2.5 per cent of total value, minimum of \$50, maximum of \$750	Buyer pays \$55 per trade plus GST. Seller pays 3 per cent of total value plus GST, a minimum fee of \$55 up to a total fee of \$550.	Buyer pays 1.5 per cent of total value. Seller pays 3 per cent of total value.
Fee charged for trade in water entitlement	Seller pays 2.5 per cent of total value, minimum of \$50, maximum of \$750.	Buyer pays \$110 per trade plus GST. Seller pays 3 per cent of total volume, or a minimum fee of \$550 up to a total of \$4400 plus GST.	Buyer pays 1.5 per cent of total value. Seller pays 3 per cent of total value.

Table 6.4: online water brokerages in Australia

(Source: PC, 2006, p.73, 90, 110.

Note: data is as of 2006. SunWater has entrusted online information to Waterfind as of 2012)

6.6.5 Reform of Trading Rules, State Government Fees and Groundwater Trading

In Victoria, water share trade and allocation trade are governed by rules set by the Minister for Water. These rules aim to facilitate trade wherever possible, while minimising negative impacts on other users and the environment. There are numerous trading rules, including restrictions on trade across zones, rules for environmental or hydrological purposes, restrictions on interstate trade, closing dates for trade, and an intention to sell requirement (PC, 2006, p.81). However, this section (6.6.5) explains only about trading zones, state government fees and groundwater trading.

- Trading zones

According to the Victorian Water Register (VWR), the definition of a trading zone is as follows:

A defined area within which trade between users can always occur, or can always occur subject to a few set conditions.

Trade between trading zones may in some cases also be possible subject to the conditions defined in the trading rules.

In other words, it means that water transfer is not permitted in areas other than trading zones. The PC report describes the purpose of trading zones as follows:

Zones are used to determine where seasonal allocations can

and cannot be traded, and at what times. In some regions, trade is restricted to within a prescribed zone (PC, 2006, p.81).

In northern Victoria, trading zones were specified as shown in Figure 6.8 and dealings between trading zones are specified. Looking at a zone, the ‘a’ type dealings can be dealt with for ten zones (1A, 1B, 1L, 3, 6, 6B, 7, 10, 11, 12), but the ‘b’ type’ dealings can only be dealt with for five zones (4A, 4C, 5A, 13, 14). Here, ‘a’ and ‘b’ have the following meanings:

- ‘a’ indicates that trade is always permitted, for allocation and entitlement
- ‘b’ indicates that only ‘backtrade’ is permitted for allocation and that trade of entitlement is not permitted.

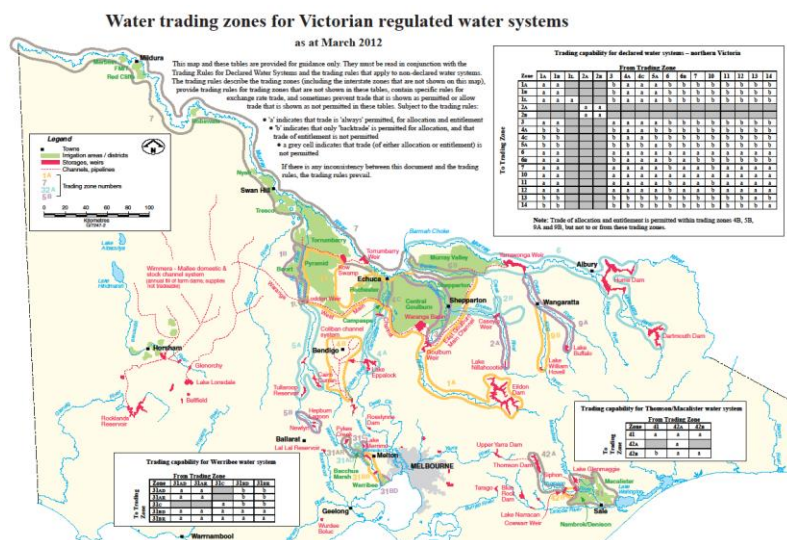


Figure 6.8: water trading zones for Victorian regulated water systems
(Source: http://waterregister.vic.gov.au/Public/Documents/water_per_cent20trading_april2012.pdf, accessed 20 August 2012).

These zones are created from environmental, hydrological and administrative necessities like below:

Some zoning restrictions have been imposed as a means of limiting any environmental externalities resulting from water trade. In particular, trade into salinity-affected zones is often restricted through prohibitions (in the highest salinity impact zones) or levies and offsets (in more moderate impact zones). (PC, 2006, p.82).

On the other hand, the Australian Competition and Consumer Commission (ACCC) raised the concern that some trading zones may have been set arbitrarily and may unnecessarily restrict trade in some regions:

Queensland and South Australia's water resource plans often prohibit the trade between defined management zones. Concerns have been raised regarding the arbitrary nature and large number of these zones in both states. For example, South Australian management zones were originally created for administrative reasons (sub. 42, p.4 as quoted in PC, 2006, p.82).

Finally the PC report describes this problem as follows:

There may be some scope to liberalise trade between expanded zones, or to distinguish time periods when trade is and is not allowed. Ideally, zones should be based on hydrological or environmental considerations. Restrictions should be periodically reviewed and removed if not justified (PC, 2006, p.82).

- Tax, fees and approval times

In the present system, all the water tradings need the permission of the state government. The total charge paid to a state government has a big difference for every state and is spread from A\$275 to A\$525 in the Allen Consulting Group (PC, 2006, pp.106–7). In addition, various permissions use approvals, land and water management plan approvals, and salinity and drainage assessments are required (PC, 2006, p.106). Moreover, in attaching or removing mortgage(s) to water entitlements, a further A\$1000 is needed (PC, 2006, p.107). And, in dealing water entitlements, the payment of capital gains tax or stamp duty is needed to the government again (PC, 2006, p.108).

As a whole, the report said transaction costs charged by government and brokers are only about 3.5 per cent of the total value of the trade (PC, 2006, p.110).

Next, the period required concerning permission for permanent trading varies from four weeks to six months, except in pre-approved areas (PC, 2006, p.109). However, this information is as of 2006.

It is clear that these regulations (including fees and approval times) have a negative influence on the activation of a water market as a whole. Concretely, the research findings of Heaney *et al* (2004) are quoted in the PC report on the size of the influence of regulation as follows:

... removing impediments to trade would result in approximately 600 gigalitres of additional trade in water entitlements in the southern Murray-Darling Basin in the short term (approximately 15 per cent of total water entitlements in the region at that time). (Heaney *et al.*, 2004 as quoted in PC, 2006, p.114).

Therefore, efforts to adjust the difference in the standard for every state and to minimise the costs and time concerning governmental approval will be required.

- Groundwater trading

The findings of the PC in respect of water trading of groundwater are quoted below:

In some areas, trading in groundwater could make extraction levels unsustainable. This is because many aquifers are already over allocated such that if licence owners are able to realise the value of groundwater through trade, a number of currently unused groundwater licences may be activated. The risk of over-extraction is increased in the Murray-Darling Basin by the fact that the Murray-Darling Basin cap is imposed on surface water alone and not all groundwater sources are capped separately. Given the substitutability between surface water and groundwater, increased trade in groundwater could exacerbate problems of system-wide over-allocation. To move ahead, appropriate integrated surface water and groundwater caps would be needed and the issue of unactivated licences addressed (PC, 2006, p.112).

For details about the problems accompanying state government fees and the problem associated with groundwater water trading, refer to Chapter 4 in the PC report. The analysis of the relation between the price of water and dams and infrastructure is separated and described in Chapter 8.

Chapter 7

Water Industry Reform: Corporatisation

Section 1 Introduction

This chapter considers reform in the water industry using three structural reform pillars as described in Section 1 of Chapter 6. Water industry reform can also be positioned as part of public sector reform, but it also constitutes the core portion of water market reform.

A market enables water trading of water entitlements. However, water cannot actually be delivered automatically. For traded water to be used, it is necessary to deliver water from the seller's source to its end use site, even if for a temporary as opposed to a permanent trade. Moreover, in order to maintain a stable service a large-scale investment and management of infrastructure construction, such as dams, channels, pumps and water supply networks, and maintenance of the executive organisation required is indispensable. We will call the services connected with such water development and delivery services the **water industry**. Formerly the water industry was a public entity. However, the introduction and development of the water market introduces new problems and subjects for the conventional water industries and for water resources

management. Specifically, the following issues highlight reforms that will be needed:

- It is necessary to correctly deliver only the quantity of water specified, at the specified time, as a result of trading. Hence the water must be gauged correctly and controlled remotely.
- With trading, a mechanism must be established to transfer monies. This requires the introduction of an accounting and management control system, reorganisation of the public entity, and personnel training in the accompanying information technology.
- Construction of the water market itself is needed. Public presentation of price information, construction of a pricing system, establishment of web pages, online trading etc. are needed. However, these services can be commissioned from outside or can also use systems other contractors have made.
- If water trading is activated, it will become possible to position it as a new income source. It will therefore be necessary to educate staff to perform sales activities. Moreover, the reform of farmers' management awareness and cost consciousness will be necessary, or utilising a water market as a base for efficient farm management will

have to be proposed (refer to Chapter 6, Langford *et al.*, 1999).

The above-mentioned reforms generally explain the necessity for water industry reform to accompany the development of a water market. However, these reforms alone will not be sufficient to explain the size of the change in the water industry of Australia. In order to perform the above-mentioned reforms thoroughly, another reform is required especially in Australia: this is the separation of irrigation (and urban) water supply services from public services (i.e. corporatisation).

Public services are provided only within fields that private enterprise cannot offer, or cannot initially offer. For example, the reasons some services, such as a railroads, aviation, telephones and telegraphs, water, electric power, mail, education, medical treatment and welfare, are often supplied by the public sector are as follows:

- (1) The possibility that there will be two or more entities offering the services, and competition will occur among them, is low.
- (2) It is necessary to consider social fairness, such as between income levels and between regions.

- (3) Since economies of scale are large, natural monopoly is the most efficient path, expense-wise.
- (4) It is necessary to take the negative impact on the environment into consideration.

The public sector took charge of water services for such reasons and traditionally did so in the form of a government business enterprise (GBE). However, it has enabled private enterprise to be substituted for certain services or projects. For example, if dam construction is required and viewed as a construction project, there is no reason the public sector must perform it. Moreover, through the development of computerisation and transportation technology, even if large cost cuts and personnel reductions are attained, the public sector would be unable to respond sensitively to such changes.

However, during the 1980s the accumulation of a budget deficit and environmental destruction required big changes in contemporary capitalism (hybrid capitalism of the market and the government). Corresponding to the change, neoliberalism and Thatcherism raised the necessity for radical reform. That is, in the 1980s, radical public sector reform became a common, unavoidable subject of contemporary capitalism.

Australia separated the policy design function and the execution function in water service reform. There was bold and

thorough reform of the whole water service as an executive organ from the public sector. Although the process can be characterised as commercialisation or corporatisation, it is thought that Australia was able to achieve the important result of not only succeeding in structural contemporary capitalism reform but, through that, also building an efficient water market in the field of water reform. This is hugely impressive and deserves global examination as a successful example. We should also understand Australian water industry reform as part of public sector reform and not simply as part of a water market reform. That will explain the reason Australian water reform progressed rapidly from water market reform at the state level to water reform at the federal level.

The composition of this chapter is as follows.

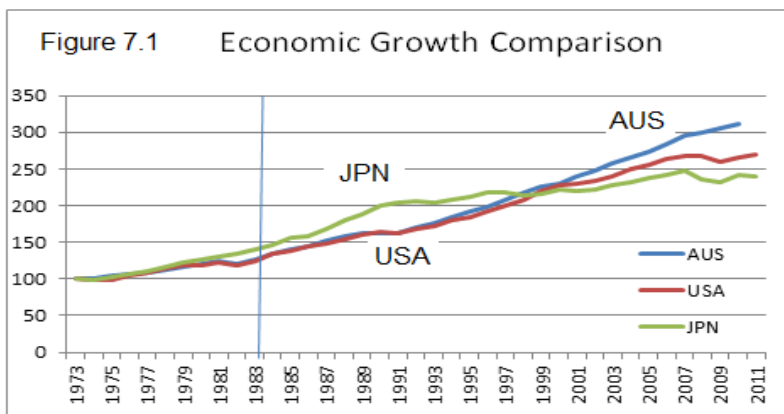
First we examine the process of water industry reform. Although looking at the global image is not easy, it can be roughly divided into price reform and public sector reform (incorporation) as the main themes. For example, Pigram describes as follows:

From the beginning, Victoria appeared foremost in reforming its administrative structures, while rapid progress towards full cost recovery and rationalisation of water prices became clearly evident in New South Wales (Pigram, 2006, p.66).

Chapter 8 considers price reform and examines public sector reform in this chapter. In Section 2, it surveys the background and present condition of water industry reform as part of public sector reform. Section 3 looks at the corporatisation of the state of Victoria. Section 4 considers again the relationship between these water industry reforms and water market reforms, and the corporatisation of Australia is compared with that in Japan.

Section 2: Background and the present condition of the water industry

The USA and Japan's shift to the floating exchange rate system in 1973 opened the age of global competition for each country. With the end of the high economic growth era, each country was troubled with stagflation of inflation and unemployment and a current balance deficit.

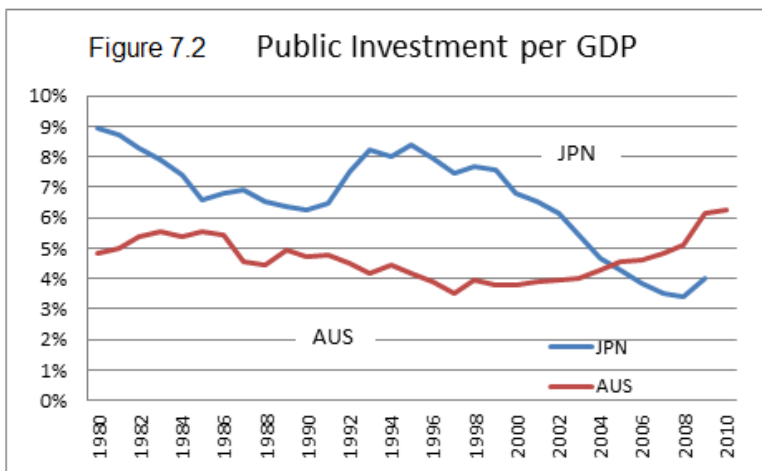


(Source: created from IMF statistics)

Through this, Japan overcame the oil price shocks by streamlining and computerisation, looked to export for the way out and continued with comparatively high growth.

In Fig. 7.1 the real GDP in 1973 is set to 100 and, compared to the subsequent transition of each country, Japan's growth was relatively favourable from 1973 to 1997 (refer to Figure 7.1).

In the 1980s, neo-liberal reform started in each country but although public investment control and public sector reform were enacted on the basis of deregulation or small government, the reduction of subsidies or public investment did not progress easily (refer to Figure 7.2). Moreover, high unemployment rates continued due to low growth and the progress of information technology. Furthermore, ecosystem destruction became an issue for the environment, debate began about the discovery of a hole in the ozone and global warming was raised as a major problem.



(Source: created from the data of ABS, Australia,
and the Cabinet Office, Japan)

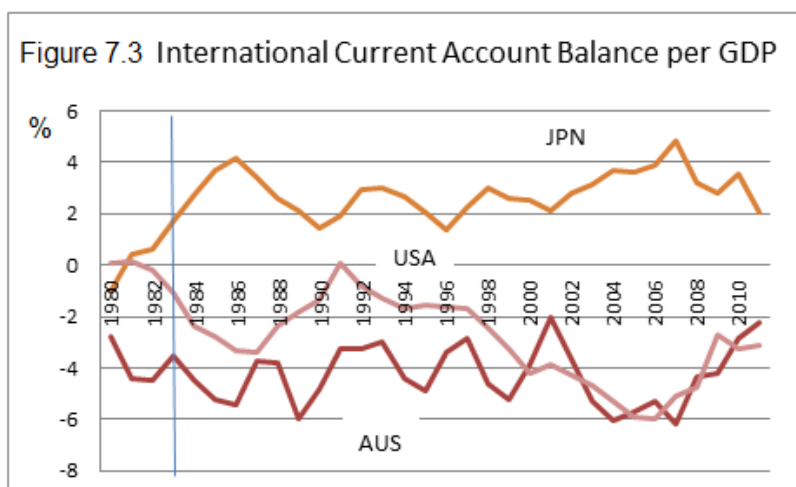
Meanwhile, as stated above, the water industry has been traditionally supplied as a public service for the reasons of natural monopoly, public responsibility and externality etc. However, when neoliberal reform came to be advocated by the Thatcherism and Reaganomics of the 1980s, the inefficiency of the public service became a target for criticism. An argument arose as to whether water industries should be positioned inside the public sector or whether they should be placed in the market where the principle of competition governs.¹ Recognition had also spread that efficiency was further lost even if public works, such as dams, seen as cost effective, destroyed limited natural environment.²

Another special condition that promoted water industry reform in Australia was the shift in the floating exchange rate system in 1983. Exports to Britain, which was once Australia's greatest export market, were being replaced by those to the Asia-Pacific region after Britain confirmed its affiliation to the European Community in 1973. Australia was pressed by the

¹ Refer to the argument on Johnson and Rix, 1993, Chapter 9, for detail.

² In Australia, the Franklin River blockade movement of 1983 led to the revision of the policy affecting dams. Moreover, the Landcare movement that became an international model for community involvement started in 1986. Refer to Section 2 of Chapter 1 for detail.

necessity to radically re-examine its traditional export policy. Industrial and micro-economic reform became inescapable after re-examining its domestic industries protection policy, and its global competitiveness in the export market strengthened with growth in trade to the Asia-Pacific region.³



(Source: created from IMF statistics)

Against such a background, the Labor administration put water industry reform into practice (under the slogans of ‘deregulation’, ‘small government’, ‘corporatisation’ and practical use of an ‘economic incentive’).

³ The Economic Planning and Advisory Council published a report about Australian public sector reform, ‘The Scale and Efficiency of a Public Sector’, in 1990. The Industry Commission published the report ‘Water resources and Waste Water Treatment’ in March 1993, and the Hilmer Committee was also published a report in 1993. Refer to Figure 7.3.

Next, we will survey the present condition of the water industry.

First we will define the water industry anew. If it is groundwater and river water, in order to send water that is a natural resource to an end user, the construction and maintenance management of various infrastructures are needed. Furthermore, it is necessary to collect and process the drainage after use, so that a fixed water quality standard may be met, and it is necessary to return the water automatically. To continue this hydraulic process requires the participation of various business units and management. We will call the whole business unit and management in connection with this hydraulic process the **water industry**.

Water industry can be roughly divided into two stages. The first is the enterprise stage at which storage facilities, such as dams, are built and managed, and water is supplied to a water supply contractor. For simplicity's sake, it will be a wholesale enterprise. The second stage purifies the water supplied by the dam administrator and uses gravity or pressure to supply an end user through a pipe or an agricultural channel. For simplicity's sake, it will be retail trade. With an actual water industry, when both stages are united, or when users intake and use private pumps from a river directly, it does vary, but the fundamental structure has the two phases of structures mentioned above.

The present Australian water industries function as follows. For the first (wholesale) stage River Murray Water (RMW), which is one section of the MDBA, took charge of the dam construction and management within the Murray-Darling River Basin. The water utilities of each state, called water corporations, take charge of the other areas. For example, the Melbourne Water Corporation has a source different from the Murray-Darling River Basin, manages some dams itself and provides three water supply utilities with water. As for the second (retail) stage, each state's water utility takes charge of delivery to the end users. In this case the actual conditions vary, although water utilities that supply water for irrigation are called rural water utilities and those that supply water for cities are called urban water utilities. For example, Southern Rural Water and Goulburn-Murray Water and Grampians Wimmera Mallee Water not only engage in retail service, but also take charge of wholesale business in the rural area of Victoria.

The situation of each state is shown generally in Table 7.1.

	Urban Water Utilities	Rural Water Utilities
NSW	Sydney Water Corporation (corporatised in 1995)	<ul style="list-style-type: none"> • State Water Corporation • privately owned corporations • cooperatives
Victoria	Melbourne Water Corporation (incorporated as a successor of Metropolitan Board of Works in 1995. It holds three water companies: City West Water, Yarra Valley Water and South East Water)	Four government-owned water corporations: <ul style="list-style-type: none"> • Goulburn-Murray Water • Southern Rural Water • Grampians Wimmera Mallee Water • Lower Murray Water

South Australia	South Australian Water Corporation (corporatised in 1995)	• Infrastructure operator pump from the River Murray and supply water directly to individual irrigators
Queensland	Water supplies are owned and managed by over 170 registered service providers, including <ul style="list-style-type: none"> • SunWater (corporatised in 2000, and transitioned to a company Government Owned Corporation in 2008) • Gladstone Area Water Board (GAWB) • Mt Isa Water Board (MIWB) • government-owned business etc. 	

Table 7.1: outline of the water industries of Australia in 2012

(Source: created from Pigram, 2006, p.95; PC, 2006, p.112-3, Victorian Government's web pages)

The situation in Victoria is as shown in Table 7.2.

	Metropolitan	Urban	Rural
Wholesale	Melbourne Water(1)	Southern Rural Water(5) Goulburn-Murray Water(6) Grampians Wimmera Mallee Water(7)	
Retail	City West Water(2) South East Water(3) Yarra Valley Water(4)	Barwon Water(8) Gippsland Water(9) Central Highlands Water(10) Coliban Water(11) East Gippsland Water(12) Goulburn Valley Water(13) Grampians Wimmera Mallee Water(7) Lower Murray Water(14) North East Water(15)	Southern Rural Water(5) Goulburn-Murray Water(6) Grampians Wimmera Mallee Water(7) Lower Murray Water(14)

		South Gippsland Water(16) Wannon Water(17) Western Water(18) Westernport Water(19)	
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Table 7.2: the water industries in the state of Victoria in 2012

(Source: created from Victorian Government's web pages)

Nineteen water corporations exist in Victoria as of August 2012. These corporations provide a range of water services to customers within their service areas. These include water supply, sewage and trade waste disposal and treatment, water delivery for irrigation and domestic and stock purposes and drainage and salinity mitigation services. Four of the water corporations provide rural water services that comprise water supply, drainage and salinity mitigation services for irrigation and domestic and stock purposes. These are:

- Southern Rural Water
- Goulburn-Murray Water
- Grampians Wimmera Mallee Water
- Lower Murray Water ([http://: www.water.vic.gov.au](http://www.water.vic.gov.au) accessed 20 August 2012).

Section 3: Corporatisation in the State of Victoria

7.3.1: Overall Flow of Water Industry Reform

The chronology of water industry reform in the state of Victoria is as follows.

	State of Victoria	Federal and Others
1980s	<p>Mr Cain of the ALP came into power on 2 April 1982 (until 10 August 1990.)</p> <p>1984 Rural Water Commission and Department of Water resources created</p> <p>1986 'Landcare' Movement started</p> <p>1987 Temporary transfer of water rights started</p> <p>1988 'Dartmouth Water' auctioned</p> <p>1989 Water Act</p>	<p>Mr Hawke of the ALP came into power of federal government on 11 March 1983 (until 2 December 1991).</p> <p>1983 Australia sifted to floating rate system.</p> <p>1983 Franklin River Dam Blockade in Tasmania</p> <p>1988 MDBC founded</p>
1990s	<p>Mr Kirner of the ALP came into power on 10 August 1990 (until 6 October 1992).</p> <p>1991 'Rate Protest'</p> <p>1991 Permanent transfer of water rights started</p> <p>1992 Rural Water Corporation created</p> <p>1992 Interstate trading (options) was trialled</p> <p>Mr Kennett of the Liberals came into power on 6 October 1992 (until 20 October 1999).</p> <p>1994 Four autonomous regional authorities created</p> <p>1994 Catchment and Land Protection Act</p> <p>1994 Interstate temporary trading started</p> <p>1995 Rural Water Corporation ceased to exist</p> <p>1995 Melbourne Water created</p> <p>1998 <i>Northern Victoria Water Exchange</i> opened</p> <p>1998 Pilot Interstate Water Trading Project (permanent) implemented</p>	<p>Mr Keating of the ALP came into power of federal government on 20 December 1991 (until 11 March 1996).</p> <p>1992 Earth Summit in Rio de Janeiro</p> <p>1992 National Strategy for ESD</p> <p>1992 Industry Commission report on water reform</p> <p>1993 Hilmar Committee</p> <p>1994 COAG's Water Reform Agenda</p> <p>1994 <i>Waterexchange</i> opened (NSW)</p> <p>1995 Imposition of the MDBC 'Cap'</p> <p>1995 National Competition Policy</p> <p>Mr Howard of the Liberals came into federal power on 11 March 1996 (until 3 December 2007).</p> <p>1998 River Murray Water created</p>

After 2000s	2002 Watermove opened 2004 Our Water Our Future released 2007 Victorian Water Register started 2012 Watermove closed	2002 Living Murray Initiative 2004 National Water Initiative 2007 Commonwealth Water Act, and MDBA created (2008)
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Table 7.3: chronology of water industry reform in Victoria

(Source: created from Langford *et al*, 1999, and
Victorian Government web pages)

It can be said that Victoria's water industry reform began with the establishment of the Rural Water Commission (RWC) and the Department of Water resources in 1984. Although this is detailed by Langford *et al* (1999, Chapter 4), the background to this development is that Australia in those days was faced with not only big financial stagnation, but also environmental, and the federal government and Victorian government were aware of people's expectations for radical reform at a time when the Labor Party (ALP) maintained continuous political power at both the state and federal level for about ten years.

Before the establishment of the RWC, 450 water utilities supplied water to urban and rural areas under the State Rivers and Water Supply Commission (SRWSC) which was established in 1905. The finances of the SRWSC were controlled by the government and management expenses required parliamentary approval. Such a financial system lacked incentives, either for a reduction in expenses or an increase in

income. The new infrastructure investment fund was also supplied by the government, without fully taking into consideration the income that investment generated. The prices for water in the 1960s and '70s were very low at A\$2/ml (about A\$10/ml at 1994/95 prices), and any incentives for irrigators to save water failed to function (Langford *et al*, 1999, p.38).

However, a new department (the Department of Water Resources) was established in 1984 and the RWC's area of responsibility was clarified as performing the functional assignment of the water resources policy and acting as an executive organ, with responsibility for water quality control being transferred to the Environmental Protection Authority.

That is, following the administrative reform of 1984, the RWC can now concentrate on reform which shifts towards being an autonomous management organisation independent of a governmental subsidy. The reform can be classified into three periods and four levels. It is summarised in Table 7.4 to show three periods of the RWC.

Financial Management Strategy	1990/91 Business Plan	Future Management Review
Responsible organisation: Rural Water Commission, Government (Vic)	Rural Water Commission	Rural Water Corporation

Planned period: 1985/86—88/89	1989/90—1994/05. However, it was interrupted in 1991.	1991/92—1995/96. However, business was shifted in four new organisations in 1994, and RWC ceased to exist in 1995.
Plan: <ul style="list-style-type: none"> • RWC reduces 30% of expenses over four years in spite of inflation. • Government takes charge of \$400M of the past debt. • RWC pays the debt of \$68M which SRWSC added. • The water price is raised 2% per annum in real terms. 	<ul style="list-style-type: none"> • Income increases by \$20M in five years. • Expense is reduced \$11M in five years. • Maintenance increased by \$5.1million, and capital expenditure on renewal of infrastructure increased by \$9.5 million • Government subsidies reduced by \$16 million • Water price is raised 2.8% per annum in real terms. 	<ul style="list-style-type: none"> • Water price is raised 2.1% per annum in real terms. • Capital subsidies from the government to become zero by 2001. • The burden of \$269M of partial pension among salaries will be moved to RWC after 1 July 1992.
Results: <ul style="list-style-type: none"> • Succeeded in reduction of target cost • Government pays \$400M. • The conclusion of \$68M was carried over. • A water price boost of 0.9% in real terms 	<ul style="list-style-type: none"> • Enforcement was interrupted in two years by 'rate protests'. <p>However, the subsidy from the government was reduced \$2M.</p>	<ul style="list-style-type: none"> • Government installed a Board in five RWCs in 1992. • The government paid the total debt \$102.4M, containing the \$68M, as of 1992. • Government paid partial of \$269M • Government agreed to purchase the corporation's housing stock for \$12 million. • The financial accountabilities and performance targets were clear and the corporation had sufficient resources to

		accelerate the restructuring.
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Table 7.4: three plans and results of RWC reform

(Source: created from Langford *et al*, 1999)

- The first period (1985 to 1989): the method of clearing the old amount of debt between the government and the RWC was agreed upon in the financial management strategy. The government paid A\$400m, which was the past debt, plus its interest burden. For its part, the RWC achieved the aim of reducing 30 per cent of expenses over four years in spite of inflation. Moreover, the private accounting system was introduced into the government business enterprise: a statement of profits and losses (P/L) and balance sheets was created and used as the basis for a five-year plan for establishing management. The rise of the required water price was planned with 2 per cent of the annualised rate in real terms.
- The second period (1990 to 1991): in response to the success of the first term, the 1990/91 business plan was decided upon. In this new plan, the required price boost was calculated at 2.8 per cent of the annual rate (in real terms). However, inflation advanced at 8 per cent, so the water price needed an 11 per cent rise. Furthermore, sadly, the goods prices of agricultural products crashed and

dissatisfaction whirled in the irrigation community. Rate protests by the irrigation farmers occurred in 1991 and forced the government to promise reexamination of the business plan. This became the future management review of 1991/92. However, although the 1990/91 business plan was experienced for only two years, it set a precedent for the reduction of government subsidies and made people realise that water organisations can become independent.

- The third period (1992 to 1994): the future management review of 1991/92 fundamentally followed the contents of the 1990/91 business plan. The Rural Water Corporation was established in place of the Rural Water Commission. Basic policies were defined, such as plans to reduce the RWC from nine areas into five, shift to independent management and install a board from the area in the RWC, from 1993. (Integration was eventually set at four regions). The RWC completed the planned changes ahead of time and ceased to exist in 1995.

7.3.2 Accounting System Reform

The contents of reform were consistent, although reform of the RWC was obliged undergo some corrections due to the rate protest in 1991. As the following figures show, these reforms

can be divided into four levels which we present for consideration.

First, the Cain Labor Government gave the state of Victoria the following reform goals:

- to stimulate the development of more profitable irrigation enterprises
- to reduce the emerging burden on the government of financing the renewal of aging irrigation infrastructure (Langford *et al*, 1999, p.37).

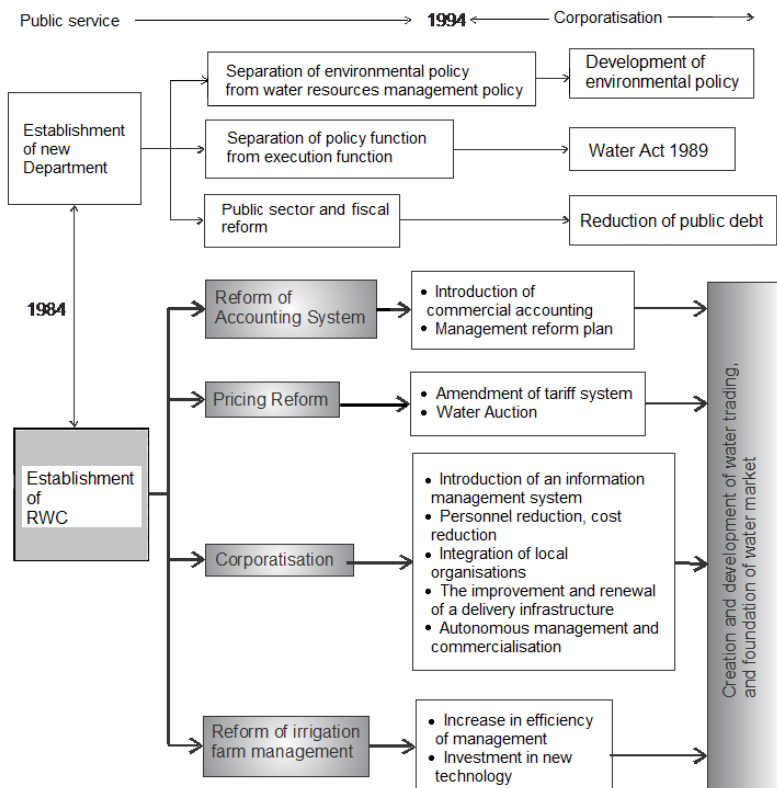


Figure 7.4: four levels of the RWC reform

That is, while increasing the competitive power of irrigation agriculture, it introduced water supply organisations that could meet the cost of infrastructure without depending on government subsidies, and continue to do so in the long run. Although commercialisation and the autonomous management of water organisations are well advanced, and there is a recognised need for price reform to secure an income, plus founding a management reform plan, there was the problem of how to clear past debt and interest burdens and ascertain the true nature of the present assets and liabilities.

However, in a situation where there were no clear accounting conventions and various hidden subsidies existed, it was serious work to draw up fiscal statements, such as profit and loss statement and balance sheets. While income was A\$75.5m, expenditure was A\$142.4m and in 1984/85 the RWC was in a serious financial state, with a deficit reaching A\$66.9m (Langford *et al*, 1999, p.64).

The RWC took the following six strategies for reform:

1. Clarify government responsibility for historical debt and unfunded liabilities for staff superannuation;
2. Define the irrigation business and provide support to the business with high quality commercial accounting and financial information systems;

3. Negotiate with government in setting challenging targets for productivity improvement; invest in staff training to create a smaller, more highly skilled organisation focused on providing services to irrigators;
4. Define the financial resources required to renew the ageing irrigation infrastructure;
5. Broaden the revenue base and sell non-essential assets;
6. Invest in research and development to improve cost effectiveness both in operations and the renewal of infrastructure; and finally
7. Progressively increase water prices to achieve financial self-sufficiency for the irrigation authority (Langford *et al*, 1999, p.64).

Introduction of Commercial Accounts

The cash accounting system was introduced at the time of the State Rivers and Water Supply Commission, a forerunner of the RWC, and a profit and loss statement was drawn up in 1984/85. In the time of the Rural Water Corporation big improvements were made in accounting systems to grasp all the costs involved.

- Superannuation benefits formed 21.5 per cent of a total salary of A\$60m. New superannuation schemes were

applied to the new personnel and, as a result, superannuation benefits decreased to 12 per cent.

- The water organisations had paid neither unemployment insurance (Workcover or workers' compensation insurance) nor infrastructure insurance money. These were processed by the subsidy and the amount of money reached about A\$800,000.
- Although the commission's income is in the quarter of the last fiscal year, salaries have to be paid every month. For this reason, the fund for salary payment was borrowed in advance from the bank, and about A\$4m of that interest rate expense was provided by the subsidy (Langford *et al*, 1999, p.65). It could stop these by improving the customer information and billing system and raising the payment frequency.

Although such reform was not welcomed by the irrigation farmers, the commission believed it led to the long-term continuation of an irrigation system (Langford *et al*, 1999, p.66).

Classification of Profits and Costs

Profit and loss statements and balance sheets could finally be

created through such efforts. As a result, the total income could be broken down into individual profit centres, the varying subsidy levels could be seen, and it became a starting point of accounting reform.

- Following examination by an audit firm the common cost (overheads) of all regional offices and the central office were sent to profit centres and were also calculated as expenses according to each expenditure scale. The common cost was changed to a causal base in 1991. Thereby, a common cost could be linked to services.
- The business plan for 1990/91 planned to cut A\$7m from running costs (A\$85m in total) over five years, every year (inflation not included). As a result, it succeeded in reducing A\$14m every year (Langford *et al*, 1999, p.66).

7.3.3 Price Level Reform

Full Cost Recovery

Next, the problem of how far the price of water should be raised when the RWC secured the required income for attaining self-supporting management was examined. (The water price in 1984 was A\$8/ml at current prices, and meant about A\$14/ml at 1994/95 fixed price). For this reason, a policy of full cost recovery was introduced in setting up a proper water charge.

Specifically, the cost price of water was decided by the sum total of the following items:

- (1) operation costs
- (2) maintenance costs
- (3) administration costs
- (4) financial costs
- (5) renewal costs (depreciation costs)

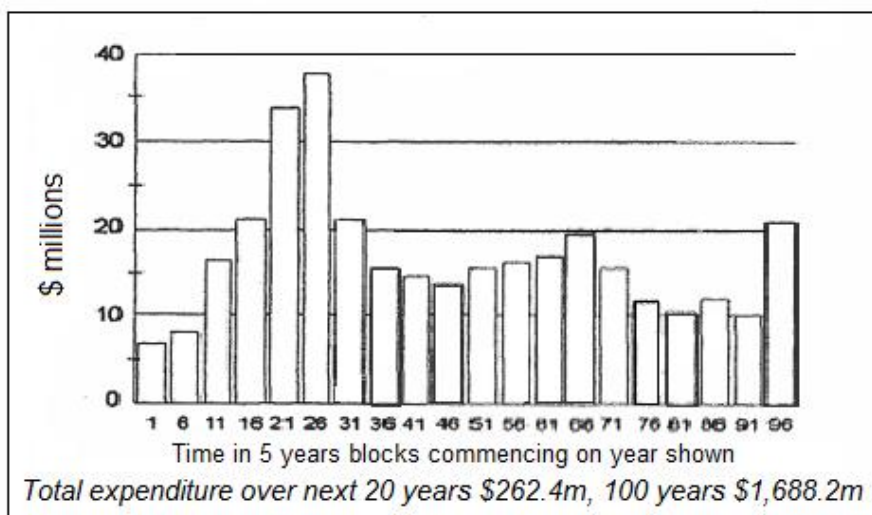


Figure 7.5: Goulburn-Murray Water, 100 year replacement profile for all services

(Source: Langford *et al*, 1999, p.40, partly modified)

When applying this full cost principle, estimating future depreciation expenses especially became a problem. For this

reason, an accountant's opinion was sought on the method for estimating depreciation expenses and it thus changed from current cost accounting into renewal accounting. This is the method used to examine in detail the contents of property, allowing for time and risk etc, and presuming a depreciation expense (Langford *et al.*, 1999, p.40). A method of dividing and registering property into six steps according to risk was also developed.

In this way, the cost of infrastructure renewal over 100 years was computed in detail from now on (refer to Figure 7.5).

As a result, although it had previously been concluded that depreciation expenses of A\$50m a year were required, in the new calculation they became A\$38m.

In this way, the RWC, which solved the problem of the depreciation expense, posited the principle that profit equals zero; i.e. a water price will set up to a full cost for twenty years from now on (until 2004/5). Application of this principle calculated that water prices served as an increasing rate of A\$25/ml and the annual price increase required was calculated as 2 per cent real per annum over the twenty years, taking into account projected efficiency improvements and cost reductions (Langford *et al.*, 1999, p.39). The government's concern begun to move from the water price to the problem of whether to double the water price and by when.

However, because inflation advanced beyond the anticipated rate, the track record by 1988/89 remained at 0.9 per cent of the annual rate to 2 per cent of the target annual rate. For this reason, a new plan was needed. This was the 1990/91 business plan.

Tariff System Reform

Water charges had previously been fixed, like a land tax, regardless of the amount of water used. For example, in Sunraysia, 9 ml/ha of water charges were collected for each hectare of land. However, about 82 per cent of irrigation farmers were using less water than this. A new tariff system was introduced, fixed charges were changed to 4 ml/ha, and the method of paying water charges according to the amount used was reformed. 1991 became a year of big changes in water charges. Water consumption was measured and fixed access charges and volumetric charges were introduced for all water consumed in the Coliban urban water supply district covering the city of Bendigo (Langford *et al*, 1999, p.59).

7.3.4: Reform of Management Organisation-Level: Corporatisation

In order to build the RWC, which was now a government organisation, as an independent management business with responsibility for the regional water supply, concrete migration

planning was formulated. This was the Rural Water Corporation's change plan for 1992 to 1994 (refer to Langford *et al*, p.67 for a detailed explanation of the whole process). The fundamental idea here was pursuing macro level centring on business units and micro level centring on work units.

7.3.4.1: The First Stage: Integration and Mergers

In 1984, when the State Rivers and Water Supply Commission was functioning, there were 450 rural water organisations divided into 20 areas. The Rural Water Commission was established in 1984 and these water organisations were unified as nine local organisations by 1992 when the Rural Water Corporation was established. Large personnel reduction was attained by this integrated merger (Langford *et al*, p.46).

7.3.4.2: The Second Stage: Establishment of Business Hegemony

A regional structure was introduced by the board of management in August 1987. The organisation with jurisdiction over the whole was called the head office and had a similar relationship as between a subsidiary and a holding company. The local organisations were defined as service units and, for the head office, the service donor and service units were understood as buyers of services. For example, when service unit

expenditure exceeded income and the superannuation portion was contained in gross pay, this portion was separated from the burden of the service unit, and head office offered it at a previously decided price. The roles of regional organisations and the central organisation were clarified by such improvements. The top-down management style (business hegemony) of the central regional office was completed after about one year of application. Deliberations with workers were indispensable to its establishment and the labour union and the Labor Party administration (at the time) played large roles. (Langford *et al*, 1999, p.68). Moreover, construction was handed over to the regional office as were lease techniques. It contributed to a flexible way of thinking about reducing capital costs as a whole.

7.3.4.3 The Third Stage: Head Office Reform

Personnel reduction at head office was performed by natural attrition. Around 1991/92, the economic difficulties became obvious and the Victorian government had no option but to start reducing the public service. Early retirement packages were also implemented. As a result, some able staff retired. The target was set of reducing head office expenses to twice those of the local offices. A doubling of productivity targets over three years resulted in substantial reductions in staff numbers at head office (Langford *et al*, 1999, p.68).

7.3.4.4 The Fourth Stage: Reorganisation of Business, and Introduction of an Information Management System

The main business reform is as follows:

- The design branch and state water laboratory, which were within the water organisation, were sold off. The state water laboratory was merged with Melbourne Water's laboratory to form Water Ecoscience, which was ultimately sold to Australian Water Technologies.
- Computerisation of office counter work was promoted. Implementation of the customer information and billing system reduced the amount of manual work in processing water rates and sales.
- Computerisation of the water supply managerial system, which is the central business of a water organisation, was carried out following three steps.

The first step of computerisation: in 1985, the channel system project started in the RWC. At the centre of this project was the introduction of the system called SCADA (modern information technology for surveillance, control and data acquisition) for making central communication and planning possible for the introduction of delivery cost reductions and a new fee structure.

This information reform was indispensable in performing new distribution services towards introduction of the water market. Langford *et al.* (1999) have pointed out the relation of this reform to a water market as follows:

Policy initiatives such as water trading, tariff reform and the development of new water delivery service could not deliver their full potential without a fundamental change to the operating systems used to manage water deliveries Improved water management will require much better integration of data systems so that costs, workforce, maintenance, water resource, water delivery and level of service data can be combined to give management much better information on performance and costs (Langford *et al.*, 1999, p.54).

The second step of computerisation: in 1991, the RWC's information technology strategy was published. This introduced the information and operating systems to allow proactive operation of the system from the headwork to the irrigator's meter wheel (Langford *et al.*, 1999, p.54).

The third step of computerisation: in 1994/95, the water management system was implemented. This was based on a mathematical model of the irrigation supply system's hydraulics so that time delays and channel capacity could be calculated. A

telemetry system provided real-time information on channel flows and water levels. A relational database allowed planners access to information on irrigators' water allocations, trading and water bills (Langford *et al*, 1999, p.56).

The new computerised delivery system built through these three steps had a big influence on the irrigation farmers.

Previously, for every small area someone called a water bailiff collected orders from the irrigation farms and the old system drew up delivery plans and transmitted them to a central administrator. The central administrator, called the head bailiff, discharged water, cooperating with each water bailiff over water demand changes, dam pondage etc. Water bailiffs managed the gates of the waterways manually and delivered water to the required farms. Orders had to be in week units, water supply was inelastic and there was much futility and numerous expenses.

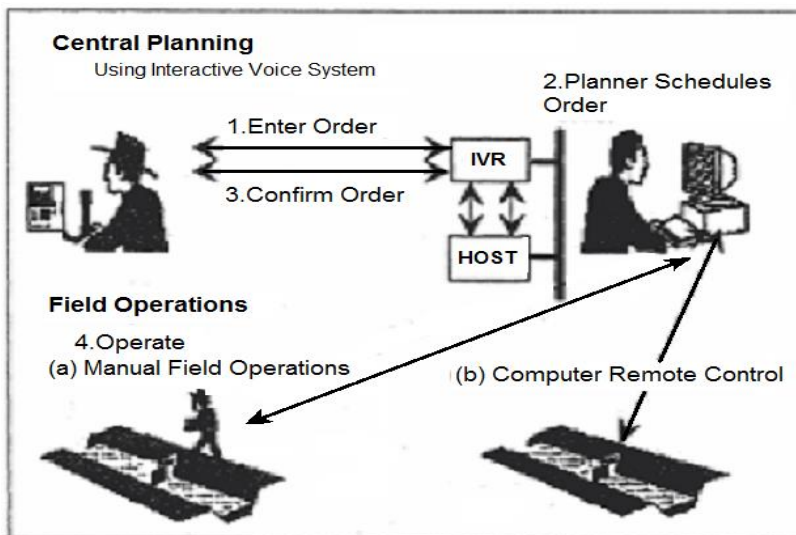


Figure 7.6: new water order and delivery system
 (Source: Langford *et al*, p.55, partly modified).

The new system introduced the technology of SCADA and created the job descriptions of 'planner' and 'field operator' to replace 'water bailiff'. Planners would accept orders from irrigation farms by telephone. The order was transferred to a remote control to operate the waterway gate instead of the previous manual operation. Planners were responsible for processing orders and deciding schedules while field operators acted on the directions of the planners, unrestricted by the former small areas. As a result, many staff became unnecessary. Although there were protests from workers, water supply service was duly carried out.

In this way, high efficiency of distribution services and cost reductions were attained. Some concrete examples are raised below.

Example1: in the Red Cliff irrigation district, water consumption decreased and it was therefore able to reduce pump expenses by about 10 per cent (Langford *et al*, 1999, p.57).

Example 2: although demand concentrated on one time, or was changed violently by the appearance of the water market for a short period of time, the new delivery system was able to respond flexibly to such changes in demand. Moreover, instead of the Dethridge wheel, which can measure only 12ml, the Dethridge-Long meter wheel, which is able to carry out 20ml measurements, was used.

Example 3: water supply to a recycling dam was started. This new service avoided peak hours on the reservoir by implementing farm dams which farms held and filled water with.

Langford *et al*. (1999) described the meaning of the computerisation of distribution services as follows:

A new operational system had been initiated with a relatively modest investment and with the support of irrigators and the workforce reflecting the more positive relationships that had developed. Operation of the channel systems was now at the dawn of new era and the capability of harnessing the benefits of the other policy initiatives was now available (Langford *et al.*, 1999, p.56).

7.3.4.5 The Fifth Stage: Staff Training and Development Strategy

Although the RWC had independent training facilities and educational programs, incorporation meant the development of new training programs was needed especially for mastering central communication and planning and for the water management system. Funds from the federal government's subsidy were injected into development of the RWC training program, which was also interlocked with the qualification authorisation system and the promotion system. Educational facilities, called ordinary vocational schools (Technical and Further Education Colleges; TAFE), were also used.

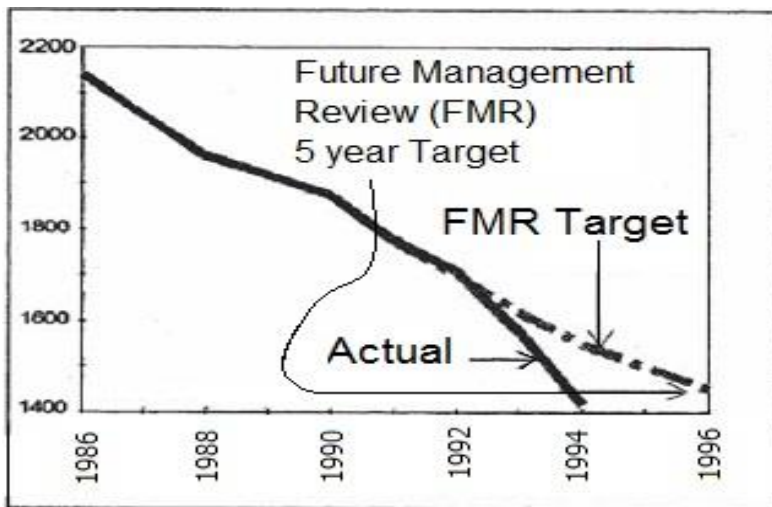
The training program was authorised by TAFE as a formal course in July 1992.

Linked to the development of the training program was the creation of a multi-skilled workforce.

Previously, the distribution services workforce was classified into at least 30 occupational descriptions, for example, water bailiff, reservoir keeper, diversion inspector, urban turncock, etc. This was due to the influence of the industrial awards that are common labour practices peculiar to Australia.⁴

⁴ An award is a ruling handed down by either Fair Work Australia or by a state industrial relations commission that grants all wage earners in one industry the same conditions of employment and wages. Awards in Australia are part of the system of compulsory arbitration in industrial relations. (http://en.wikipedia.org/wiki/Industrial_award, accessed 29 August 2012).

Different workers were in charge of operation work and maintenance work. However, irrigation agriculture delivers water in summer and stops delivery in winter. Therefore, although operation work is required in summer, maintenance work is unnecessary in winter. If one worker can perform both jobs, the required labour force will be reduced by half. The RWC negotiated with the 12 labour unions repeatedly and mediated with the unions to specify labour conditions, salary and industrial awards for this purpose. Unifying two labour functions to one not only slims employment, but forms better careers for workers in connection with construction and maintenance works, which were traditionally seen as lower than operational work. For this reason, workers responded in the affirmative to this reform. As a result, the workforce was classified into four levels and each level was reorganised with three salary steps. An increase in salary became based not on the length of service but on attaining the skill provided in the program of instruction. In this way, a multi-skilled workforce was created (Langford *et al*, 1999, p.72).



**Figure 7.7: Rural Water Corporation staff numbers,
June 1986 to June 1996**
(Source: Langford *et al*, 1999, p.46, partly modified)

Dialogue between the managing director and workers enabled such thorough labour reform (restructuring included). More than about half of the workers and the director talked together directly and, in response to the problems raised in the talks, replies were made by letter and distributed to all the workers, and the dialogue continued.

7.3.4.6: The Sixth Stage: Creation of Customer Creed Culture

The Commercial Development Project (CDP) was the next step in the strategy to create a customer-focused high-performance culture within the corporation. Specifically, making the vision and the business plan of the corporation permeate even the end work units were investigated.

7.3.4.7: The Seventh Stage: Expansion of New Profit Opportunity

Because the contracts relating to the commission's dams had existed for a long time adequate consideration was not paid towards charges. Fortunately, because of a cancellation provision in the contracts for the Eildon dam generating power, the commission was able to cancel the old contract and reform the charge. (Because there was no cancellation provision in the case of the Dartmouth dam, negotiations there ran into difficulties). A new power generation contract brought profit to the commission.

Moreover, amendment of the lease charges for land surrounding dams and amendment of boat licences (licence fees) for dam lakes which the commission owns became a new income source. In addition, the problem of community service obligations, such as water supply to churches, schools and scout

halls etc, were also re-examined. It seems that, however, it was difficult to reclaim new profit sources as a whole.

7.3.4.8 The Eighth Stage: Formulation of the Plan for a Shift

The issues required for making the shift complete by 1995/96 were overhauled and the switch over to the new system was carried out smoothly. This included a plan to unify nine local offices into five as well as the installation of the management board and the creation of the corporate business plan. Furthermore, briefing sessions were held, letting stakeholders and related communities and irrigation farms understand the necessity for reform.

7.3.5 Creation and Development of Water Trading

The above-mentioned various reforms were connected not only to the creation of water corporations but to the creation of water trading.

7.3.5.1 Water Auctions

The price of water rights (permanent trading) needs to take capital costs, such as for dams and delivery infrastructure, into consideration. Initially, there were two methods for deciding the prices: auction and tender. The irrigation community preferred auctions and the first water auction was performed in Australia.

In May 1988, the RWC auctioned 2,000ml of entitlements in Bridgewater to divert water from the Loddon River.

The average price of water was A\$239/ml. Participants in the auction were restricted to farms actually performing irrigation agriculture in the Loddon river valley. The RWC carried out a further five water auctions (Goulburn, Broken, King, Thomson and Murray rivers). Water auctions made irrigation farms aware of water as an economic good and it became an important cause for which management reform, aiming at making irrigation agriculture globally competitive, was urged (Langford *et al*, 1999, pp.50-51).

7.3.5.2: Creation of Water Trading

Langford *et al*. (1999) write that the Department of Water Resources led water trading in Victoria as follows:

The Department of Water Resources initiated the introduction of transferable water rights in Victoria in 1983 by commissioning consultants ACIL Australia Pty Ltd to evaluate the costs and benefits of transferable water entitlements (Langford *et al*, 1999, p.48).

Although temporary trading started in Victoria in 1987, the RWC actually introduced temporary trading.

After extensive consultation, and some obstruction from the Department of Water Resources, the Rural Water Commission introduced a system of temporary transferable water rights to the Goulburn-Murray Irrigation District at the start of the irrigation season of 1987/88 ... In 1987/88 a total of 242 applications were approved involving 16,345ml (Langford *et al*, 1999, p.49).

The Water Act 1989, permitting permanent water trading, was approved in 1989. The Department of Water Resources led this Bill and therefore, in Victoria, the creation of water trading was a joint enterprise of the Department of Water Resources and the RWC.

However, irrigators' reactions to the water trading at the time were complicated. At the same time, to counter the aggravation of damage from salt water to the ecosystem, opposition movements such as damming emerged again and stopped new water-for-irrigation development. It was clear that another method, such as a water market, was required to newly secure water. Moreover, in order to make water transfers from land damaged by salt water to land that is not so, the economic approach of a water market was needed, along with modernisation of the delivery institutions.

There was also the uneasiness of whether rural water would be taken to found a water market in a city. Furthermore, there

was some opposition from within the Labor Party.

Langford *et al.* (1999) write:

The Bill did not contain provisions to facilitate permanent transfers of water entitlements. The left wing of the Victorian Labor Party, the party in government in Victoria at that time, opposed the trading in water as a natural resource. [They] believed water should stay in public ownership despite the fact that private ownership of water rights, attached to land, had been in place for nearly 100 years. In the end an opposition amendment in the Upper House of the Victorian Parliament, with the tacit support of the government and the Rural Water Commission, opened the door for permanent transfer (Langford *et al.*, 1999, p.50).

In such a complicated situation, permanent water trading was tolerated in Victoria, and started there from 1991/92 following its introduction in SA and NSW.

7.3.5.3 River Murray Water Accounts and Interstate Trading

The River Murray Waters Agreement in 1915 had opted for distribution between Victoria, NSW and SA as follows:

The agreement established a formula for sharing the waters of the Murray River. The formula was simple in concept. South Australia, the downstream state was to receive a guaranteed

minimum flow. The waters upstream of Albury were to be shared equally between New South Wales and Victoria, and the downstream tributaries belonged to the state in which they originated (Langford *et al*, 1999, p.51).

However, this agreement was from a time without a system of huge storage dams and carryover systems and the portion that did not keep up with the times came out. In order to solve this problem, the RWC (Mr David Dole took the lead) introduced the view of continuous accounting and capacity sharing into the River Murray and devised River Murray water accounts. It is said that this improvement enabled the introduction of interstate water trading. And the experiment (option transactions included) of temporary interstate trade was conducted under the RWC in 1992.

As a trial, the first interstate trade in water was organised between the Rural Water Corporation and rice growers in New South Wales (Langford *et al*, 1999, p.52).

In this case, the first **option transaction** for an interstate trade was set up and paid for in the irrigation season of 1992/93 (Langford *et al*, 1999, p.53).

The structure of the first option transaction was as follows:

The rice growers in NSW could take out an option in August for the delivery of Victorian irrigation water later in the season. The option give the rice grower security to plant a given acreage

of rice knowing with certainty at an early stage the volume of water that would be available during the growing season. If the NSW water supply system could not meet the demand then the option on Victorian water would be taken up and the full bulk water price paid to the Rural Water Corporation for delivery to the off take of the NSW Irrigation System (Langford *et al*, 1999, p.52).

As stated above, the RWC created it with the Department of Water Resources, rather than being concerned with the creation and development of a water market.

7.3.6 Birth of Four Regional Water Corporations

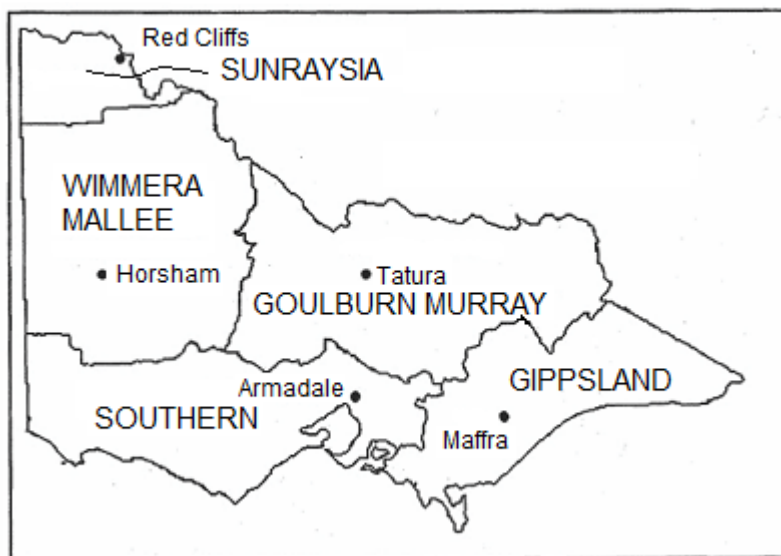


Figure 7.8: new four regional water corporations in Victoria
 (Source: Langford *et al*, 1999, p.31, partly modified)

Eventually, the water corporations were unified into four groups as follows and the water corporation that handled water supply for the rural Victoria was created in 1994 as a result of such great efforts over such long distances. The names are as follows:

- Goulburn-Murray Water
- GWM Water (Grampians Wimmera Mallee region)
- Southern Rural Water (including Gippsland region)
- Lower Murray Water (Murray-Sunraysia region).

In addition, the result of the management reform for ten years of the RWC is summarised as follows:

Overall revenue had increased 28 per cent in real terms and operating expenditure had been reduced by 32 per cent despite the large real increase in maintenance expenditure. The shortfall of revenue against business costs was reduced by 80 per cent or A\$53.6 million in real terms ... The reduction in operating costs of A\$33.4 million contributed 62 per cent of the improvement in performance. Increase in water rates and charges to the irrigators contributed A\$11.8 million or 22 per cent. New sources of revenue net of a dividend to government contributed the remaining 16 per cent of the improvement in financial performance (Langford *et al*, 1999, p.76. In addition, also refer to Langford *et al*, 1999, Table 6.1, p.64).

Section 4: Relation of corporatisation and water market

We have examined how water organisations were corporatised and the process of creating water corporations. As a result, it has become clear that the process of corporatisation and that of founding a water market were advancing as one.

The Water Act 1989 was enacted under the initiative of the Department of Water Resources in 1989 and opened up the possibility of permanent water trading. Also, under the initiative of the RWC, temporary trading began in 1987, permanent trading in 1991, and the experiment of the option of trading beyond the state occurred in 1992. In addition, temporary interstate trade started in 1994 and preparation for performing permanent interstate trade was made under the leadership of the RWC.

It is clear that the RWC was directly concerned with the creation and experiment of such a water market together with the Department of Water Resources. Moreover, the four water corporations which the RWC formed grew favourably under a self-supporting accounting system, and the G-MW, which is one of the four water corporations, founded a water market called Northern Victorian Water Exchange in August 1998. (Water Exchange was established in NSW in 1994. Northern Victorian Water Exchange was changed to Watermove in 2002 and full-scale online dealings began). GWM Water released a plan to

found a new water market to the Wimmera Mallee region in June 2012. Though it is regrettable that Watermove was closed in August 2012, for more than 15 years it led the development of the water market and contributed to the strengthening of irrigation agriculture in northern Victoria. Although other water markets and the Victorian Water Register will play the role Watermove played from now on, what kind of relation exists between the development of a water market as a whole and corporatisation?

Relationship between Corporatisation and Water Trading

As described in Chapter 6, the Water Act 1989 was the epoch-making law that enabled external and permanent water trading, and it was the practice of the RWC that enabled the creation of this Bill. It is thought that various trials by the RWC demonstrated the practicability of a water market and provided the evidentiary material for the creation and passing of the Bill to set up the Department of Water Resources. Therefore, the RWC's reform created not only water corporations but also water trading on a permanent basis. That is, the management reform of water organisations and the creation of water trading by corporatisation are considered to have been connected with the improvement in agricultural competitive power on the last target.

Langford *et al.* (1999) describe this point as follows:

Reform of water allocation policies to create markets for water and trading encourages the reallocation of water to more profitable irrigation enterprises, and gives the irrigators valuable knowledge of the opportunity cost of water Knowledge of the opportunity cost will influence decisions on water management and improve profitability (Langford *et al.*, 1999, p.47).

Thus, ultimately, corporatisation was positioned as a means for making irrigation agriculture globally competitive through the creation of water trading as a means of reducing budget deficits and subsidies (refer to Figure 7.9).

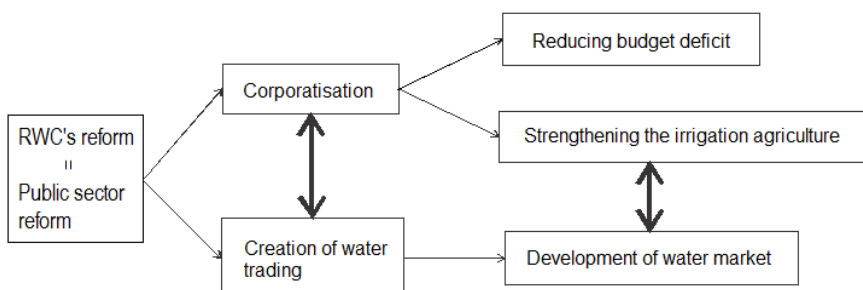


Figure 7.9: dual reform of corporatisation and water markets

The RWC performed these reforms in order to achieve two or more of these aims and it is thought that the purpose of reform led by the RWC was to create a water corporation system and a water trading system. Therefore, corporatisation of a water

organisation and creation of water trading are not separate and needs to be understood as a single unit.

However, opinions are divided about whether the foundation of a water market and corporatisation of a water organisation are inescapable. When the efficient management of a water organisation is already established, even if it does not necessarily take the form of corporatisation, I think that the introduction of water trading is possible in general. However, if the situation of the water organisations in Australia in the 1980s is taken into consideration, probably at the time a new service called water trading would have been considered impossible. Moreover, in the Australia of those days, in order to advance foundation of water trading at the same time as reform of a water organisation, it is thought that the powerful political means provided by corporatisation was required. And it is possible that the success of this corporatisation was the secret to developing Australia's water market into the world's largest. Therefore, for Australia, the corporatisation of water organisations was a necessary condition for the creation of water trading and a water market.

For example, if G-M Water or GWM Water remained as one governmental organisation instead of the present system, could not a water market like today's be created? Probably, as the development of the water market meant the water organisation

was able to achieve a certain intermediary role, even if not incorporated. However, the offering of a service to meet consumers' needs and the necessity for a profit increase were accelerated more quickly by incorporation. In addition, the new management system reform and the personnel system reform for incorporation enabled such correspondence. And probably, water corporations did their best in the configuration of easy-to-use delivery systems for customers in response to user needs and reduced the transaction costs. These have resulted in the development of a water market that has remained efficient until today.

However, some problems will probably need to be solved in order to achieve a bigger function than water resources distribution, in which the water market is further expanded by including water for the environment and for cities. For example, further integration of the water market, further reform of the management business units that handle water markets, and development of the risk management technique, development of water pricing policy, and construction of the more stable management base are probably needed (refer to 14.6 for the further argument).

Relation between Corporatisation and Irrigation Farm Management Reform

Next, I will consider the relation between corporatisation and the management reform of irrigation farmers. In order to make corporatisation successful, the RWC raised the necessity for gradual water price increases from A\$14/ml (estimated for 1994/95 year price) to A\$25/ml over the 20 years from 1984/85 to 2004/05 (a 2 per cent increase in the annual rate in real terms). Although a part of that figure changed, the sustained elevation of this water price made irrigation farmers' cost cutting and continuous efforts at productivity reform indispensable. The efforts to achieve such increases in efficiency led to the modernisation and rationalisation of irrigation agriculture in the long run and, while the management awareness of the farms changed considerably, it is assumed that it led to raising the global competitiveness of irrigation agriculture. And it is thought that the farm management reform and consciousness reform by irrigation farmers, instead of becoming affirmative in the development of a water market, actually developed conversely (Langford *et al*, 1999, p.38).

We will quote the research findings about the changes in irrigation agriculture in the southern Murray-Darling Basin from 1980 to 2000:

There is some evidence that water productivity (commodity produced per unit of water) has improved over time ... For rice,

water productivity doubled in the period from 1980 to 2000 with water used on an industry basis decreasing from 15ml/ha to 12ml/ha. For dairy in northern Victoria, there is evidence from one property of a doubling in the milk fat produced per megalitre of irrigation used from 1967 to 1991. For almonds, anecdotal evidence suggests that there has been a 28 per cent increase over the last eighteen years ... There is clear evidence from recent experiences in the Sunraysia and Riverland regions that major shifts towards more controlled irrigation systems occurs when there is synergistic investment with delivery system upgrades and on farm application systems. Upgrading delivery from open channel supply to semi pressurised pipelines resulted in an average 40 per cent reduction in the annual delivery volumes. Immediately following the installation of these piped systems there was a major shift in on farm application systems with a trebling of drip installations replacing surface furrow systems. Accompanying the conversion from furrow irrigation to drip systems is evidence that drainage to underlying groundwater was reduced as water table test wells showed increased depths to groundwater (Meyer, 2005, p.x).

The consequences of such neo-liberal reform to the rural community as a whole and to the environment should probably be evaluated carefully. For example, there is the following criticism:

The sorts of policies embraced by neo-liberal governments have accelerated agricultural restructuring. Such policies have included the deregulation of labour market; the withdrawal of trade tariffs that protect Australia's primary industries from external competition; the floating of the Australian dollar; privatisation and the withdrawal of government services; the establishment of user-pays approaches to remaining government services; the implementation of National Competition Policy; and the provision of 'structural adjustment' funding to aid the removal of farmers who are deemed unviable. The aim of these policies has been to enhance competition, which, in turn, is viewed as a positive force for economic change. The assumption is that once economic resources are most efficiently allocated, then social progress and environmental security will logically follow. However, as many writers have shown, the effects of these policies is unevenness, with social polarisation, economic decline and environmental pollution continuing across Australia, and at a time when government cutbacks ... along with a non-interventionist philosophy ... limit the capacity of the state to intervene to modify the impacts (Boreham *et al*, 2004, p.342).

When the above is summarised relative to the Australian situation, it shows corporatisation of water organisations is a necessary condition for creating and developing a water market. It became the driving force of water reform, but corporatisation

cannot certainly be generalised as a necessary prerequisite in the development of all water markets.⁵ However, for the development of a water market, it can generally be said that the increase in efficiency and conscious reform of a water organisation, including the separation of a planning function and an executing function in the public sector, are indispensable.

Australian Features of Corporatisation

Although arguing about public sector reform as a whole is not the theme of this chapter, we would like to express some views about the corporatisation of the Australian water industry, or the features of public sector reform as compared with Japan.

One reason Australian water industry reform was so thoroughly enacted relates to the agricultural sector being an important export industry that earns foreign currency for Australia. It became very important to achieve an increase in agricultural global competitiveness. Therefore, it is thought that the creation of self-supporting and efficient water corporations and a water market needed to be implemented.

⁵ China is an example of introducing water trading without the management called corporatisation. In China, water reform is advancing since the establishment of the 2002 Water Law of People's Republic of China, and at the centre are water rights reform and the introduction of water trading. Water trading is conducted among local governments and if it is water trading at this level, it is thought that large-scale reform, like Australia's, is unnecessary. Refer to Shen & Speed, 2010.

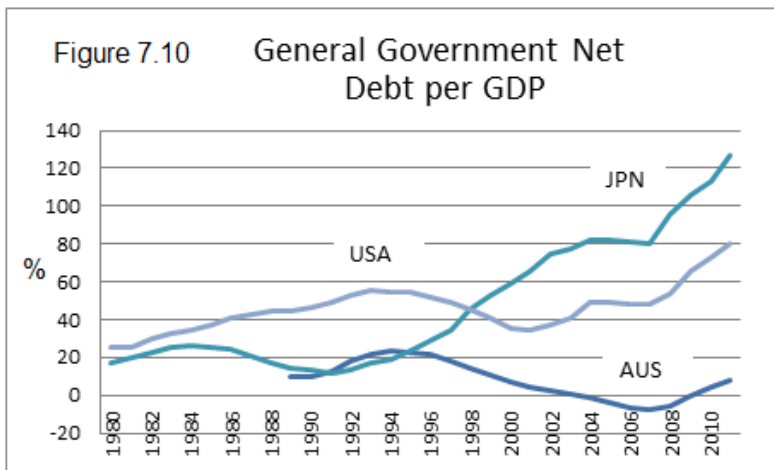
Another reason for corporatisation's relative success is that Australia is a decentralised political administration system within a federal system. Because Australia is a state-based administration system, a public sector can be reformed quickly. It is thought that the problem was able to be coped with relatively easily to change the fiscal structure of the central government. For this reason, it seems that there was comparatively little friction politically and reform happened easily. Compared with this, in the case of a centralised political system like Japan, local reform cannot but interlock with central reform. Therefore, it is thought that administrative and fiscal reform such as the corporatisation of a public sector involved in the overall central system makes big pain and big political leadership inescapable.

Thirdly, both at federal government and state government level, the Labor Party's long-term stable political power enabled long-term continuous reform and could also be seen as a reason this reform succeeded.

The Australian reform, which started in 1984, was administrative and fiscal, public sector reform, water industry reform, irrigation agrarian change, water market reform, and neo-liberal reform of contemporary capitalism by the Labor Party. Therefore, the crucial reforms were in connection with the globalisation of contemporary capitalism. It can be said that

Australia made this successful over a period of 20 years. Compared with the neo-liberal reform of public sectors in Japan, it turns out that the incorporation of Australia was scrupulously planned and has succeeded relatively well. Japan was absorbed at the time in a bubble boom and resort development, such as the construction of golf courses, hotels and airports in the second half of 1980s. It seems that this difference led to the inversion of the growth path of Japan and Australia in 1998, and afterwards, acceleration of Japanese government debt, and the secular stagnation of the Japanese society (refer to Figure 7.1 and Figure 7.10).

We have to say that the experience of Australia has provided many valuable lessons about reform of contemporary capitalism.



(Source: created from IMF statistics)

Chapter 8

Water Pricing and Water Pricing Reform

This chapter conducts a theoretical examination of the price of water and examines Australian water price reform. Section 1 considers the relation of property (water assets) and profit which is an important factor in specifying the price of water (or water cost). Section 2 considers NSW's pricing reform. Section 3 considers pricing reform at the federal level. Section 4 is the summary and conclusion.

Section 1: Fundamental relation of property and net return

What kind of level should be decided for the price of water, i.e. the price of water rights? In order to consider this problem extensively, we have to analyse factors such as the influence on consumers, social equity, environmental externalities and the consideration of various risks. Since it is not realistic to take all these into consideration, we look theoretically at infrastructure expenses and the relation of water price to the acquisition of water and water supply and examine an example. It is thought that the most important factor influencing the actual water price is the cost of infrastructure.

8.1.1 The relation of sustainable property and net return

First, the fundamental matter of property and a net return is arranged, and we use this to consider a sustainable case.

The amount of investment is set to I , for which we will take out a loan from a financial institution. We will assume that the total fund is appropriated for construction of water-use facilities, such as a dam. A payment period is for T years and a borrowing rate of interest is taken as r over a long period of time. On the other hand, repayments equal X amount of money every year. Payment of the debt will be completed if the total present value amount at the time of repaying this amount of money for T years (after the present value in the case of repaying the amount of money of X in t years being $X \cdot e^{-rt}$) becomes equal to the investment expense I . Therefore, generally the following equation is realised.

$$I = \int_0^T X \cdot e^{-rt} dt = \frac{X}{r} \cdot (1 - e^{-rT}). \quad \text{-----}(1)$$

If this is solved for X , it will be set to

$$X = \frac{r}{(1 - e^{-rT})} \cdot I. \quad \text{-----}(2)$$

This is a general formula showing the relation between the investment scale I and the amount repaid X per year.

Next, renewal of institutions is needed at the same time repayment of a debt will finish in T years. It is necessary to accumulate the amount of money I equal to the present amount

of investment in T years, and to prepare it then. It is necessary to set the depreciation expense of each year to D , and D needs to deposit then fill the following relations with the long-term deposit interest rate of ρ to a financial institution.

$$I = \int_0^T D \cdot e^{\rho(T-t)} dt = \frac{D}{\rho} \cdot (e^{\rho T} - 1).$$

Therefore, it becomes

$$D = \frac{\rho}{(e^{\rho T} - 1)} \cdot I. \quad \text{-----}(3)$$

This formula gives the amount of money D which must be saved every year in order to prepare a fund equal to the amount of investment I in T years.

Next, the relation between the property K [which continues producing the profit $R(t)$], and profit $R(t)$ is considered for each year. We would like to set a profit rate or a risk premium to π and to secure the profits of $\pi \cdot R(t)$ every year. We think that the amount of money (which moreover deducted the maintenance cost $M(t)$ and depreciation cost $D(t)$ per year) is repaid. The property K considers all as debt from a financial institution and sets the interest rate to r . The following equation is then realised between property and the amount X of a refund per year.

$$\begin{aligned} K &= \int_0^T X \cdot e^{-rt} dt \\ &= \int_0^T \{(1 - \pi) \cdot R(t) - M(t) - D(t)\} \cdot e^{-rt} \cdot dt. \end{aligned}$$

Furthermore, if it assumes that $M(t) = m \cdot R(t)$ ($0 < m < 1$), $D(t) = D$ (constant) and assumes that the profit $R(t)$ increases at the rate of n every term, and since it becomes $R(t) = R_0 \cdot e^{nt}$, it will be set to

$$\begin{aligned} K &= \int_0^T \{(1 - \pi - m) \cdot R(t) - D\} \cdot e^{-rt} \cdot dt \\ &= (1 - \pi - m) \cdot \int_0^T R_0 \cdot e^{nt} \cdot e^{-rt} \cdot dt - \int_0^T D \cdot e^{-rt} \cdot dt \\ &= (1 - \pi - m) \cdot \int_0^T R_0 \cdot e^{-(r-n)t} \cdot dt - \frac{D}{r} \cdot (1 - e^{-rT}) \\ &= (1 - \pi - m) \cdot \frac{R_0}{r-n} \cdot (1 - e^{-(r-n)T}) - \frac{D}{r} \cdot (1 - e^{-rT}). \end{aligned}$$

Furthermore, if (3) is substituted for D in the upper formula,

$$K = (1 - \pi - m) \cdot \frac{R_0}{r-n} \cdot (1 - e^{-(r-n)T}) - \left(\frac{\rho}{r}\right) \cdot \frac{(1 - e^{-rT})}{e^{\rho T} - 1} \cdot K$$

will be obtained. Here, ρ is a deposit interest rate over a long period of time.

Furthermore, if this is solved about R_0 ,

$$R_0 = \left(\frac{1}{1 - \pi - m}\right) \cdot \left(\frac{r-n}{r}\right) \cdot \xi \cdot \mu \cdot K \text{-----(4)}$$

will be obtained. Here, it is

$$\begin{aligned} \xi &= \frac{1 - e^{-rT}}{1 - e^{-(r-n)T}} \\ \mu &= \left\{ \frac{r}{(1 - e^{-rT})} + \frac{\rho}{(e^{\rho T} - 1)} \right\}. \end{aligned}$$

The formula (4) has given the relation between asset K and income R_0 which, when it considers that the amount of money equal to the existing asset K got into debt, fulfills the following conditions:

(i) Secure a maintenance cost, a depreciation expense, and profits from the income per year, and

(ii) when a payment period expires, the fund required for the purchase of equipment of a scale equal to existing property is securable.

We will call this a **sustainable case**.

Numerical example: (sustainable case)

It is referred to as $r = 0.08$, $\rho = 0.05$, $n = 0.03$, $\pi = 0.2$, $m = 0.3$, and $K = 100$. $D = 1.44$ from (3). Moreover, since it is set to $\xi = 1.17044$ and $\mu = 0.102342$ from (4), it is set to $R0 = 14.97$.

Therefore, the income R of each year, the volume of profit π , the maintenance cost M , the depreciation expense D , the amount repaid (finance charge) X , and present value at t of variable X : $PT(X)$ are as follows (only a part is indicated).■

t	R	$\pi \cdot R$	M	D	X	$PT(X)$
0	14.97	2.99	4.49	1.44	6.05	6.05
10	20.21	4.04	6.06	1.44	8.67	3.90
20	27.28	5.46	8.18	1.44	12.21	2.46
30	36.83	7.37	11.05	1.44	16.98	1.54
Total						103.8

Table 8.1: numerical example of a sustainable case

In the case of this numerical example, about 15 per cent of profit of the property K at the initial time is required, since it is set to (4) to $R_0 = 0.1497 \cdot K$, and the ratio that accounts for the total income R of the depreciation expense D and the finance charge X became 57 per cent. Our problem is considered by viewing the above as preparation.

8.1.2: Relation between water property and a net return and a water charge: first step

A problem is divided into two stages and considered.

The first steps are building a dam etc, producing new water rights to river water and providing a water supply contractor (here referred to as a water utility) with water.

The second step supplies water to end users (irrigation farmers, industrial companies, city residents etc) from a water utility. We will refer to the second step in 8.1.3.

The dam construction cost, annual depreciation expenses and the annual administrative and maintenance costs are set to I , D and M respectively. The amount of water rights newly produced by dam construction is set to E and the amount of actual water used is set to H . ($H \leq E$). From the water user (in this case, the water utility), the water rights price w will be assigned and collected to the newly born water rights E . Therefore, the amount of money a dam administrator can repay every year

serves as $w \cdot E - M - D$. Although this will be repaid over T years, if the long-term interest rate for a changing future amount repaid to present value and a deposit interest rate are set to r and ρ , since the present value of t -year after becomes $(w \cdot E - M - D) \cdot e^{-rt}$, the following formulas must be used when covering the construction costs of a dam, administrative and maintenance expenses, and a depreciation expense together with water rights income.

$$I = \int_0^T (wE - M - D) \cdot e^{-rt} dt = \frac{wE - M - D}{r} \cdot (1 - e^{-rT})$$

Furthermore, in consideration of the relation of depreciation expense $D = \frac{\rho \cdot I}{(\rho T - 1)}$ described by (3), it is set to

$$wE - M = \mu \cdot I \quad \text{-----(5)}$$

Here, it is

$$\mu = \left[\frac{r}{(1 - e^{-rT})} + \frac{\rho}{(\rho T - 1)} \right]$$

If a formula (5) is rewritten about I it will become

$$I = \frac{wE - M}{\mu}$$

When dam expense is reduced only I_0 by a subsidy etc for the initial investment, it is set to

$$I = ((wE - M) / \mu) + I_0$$

When this is solved for w , it is set to

$$w = \frac{M + \mu(I - I_0)}{E} \quad \text{-----(6)}$$

and the price w of water rights and the relation with the investment scale I are known.

Example 1:

Dartmouth Dam, which is the biggest dam in Victoria, was completed in 1979 and has a pondage of 3906gl. A stable daily supply of 10,000ml of water can be ensured by this dam. The construction costs were about A\$160 million (based on the MDBA inquiry to RMW on 7 September 2012). So, if the annual maintenance cost M is set at A\$50,000, a borrowing rate of interest over a long period of time is assumed as $r = 8$ per cent, a deposit interest rate is assumed as $p = 5$ per cent, and a payment period is assumed to be $T = 30$ years, since it was set to $\mu = 0.102342$, the price (price per water rights 1ml) of water was about set to A\$5.4/ml. That is, if investment is A\$160million and the price of water rights is set as A\$5.4/ml, the maintenance cost M , the depreciation expense D and the finance charge X must be paid continuously, and in 30 years it will be possible to acquire the equipment replacement expense which is equal to the amount of investment I . In addition, several figures were as follows. (refer to Table 8.2) In this example, a depreciation expense D and the amount repaid X form 76.6 per cent of the total income $w \cdot E$. ■

Investment (M\$)	$w \cdot E$ (M\$)	M (M\$)	D (M\$)	X (M\$)	w (A\$/ML)
160	21.34	5	2.29	14.08	5.47

Table 8.2: cost of Dartmouth Dam water (virtual calculation)

However, this calculation is based on a hypothetical number and is unrelated to the view of the organs concerned. This applies also to the following examples.

Example 2:

Melbourne Water provides waterworks and sewage disposal for the Melbourne metropolitan area, with a population of about four million. However, service for residents is not provided directly but through four retail stages of contractors, called metropolitan retail water businesses. For this reason, Melbourne Water manages water supply catchments, sewage, rivers and major drainage systems and holds storage reservoirs with about 1800gl stored. The price of the real assets was A\$3667 million in 2006, including sewers (Melbourne Water, 2007, p.99).

The amount of actual water supplied in Melbourne in the 2006-07 fiscal year was 412.8gl (Melbourne Water, 2009 Water Plan, p.70). It is assumed that A\$1833.5m of water service

property (with water service property assumed to be 50 per cent of the total real assets) existed in the 2006–7 fiscal year. We will consider the level at which water rates should be set at in order for a fund of this size to sustain a long-term borrowing rate of interest of $r=8$ per cent and a payment period of $T=30$ years, and to repay from the annual income as well as pay maintenance and depreciation costs and be able to update all the real assets in 30 years. That is, the water charges will be calculated as a sustainable case.

In order to calculate concretely, the parameters are set up as follows. The deposit interest rate of a depreciation fund and administrative and maintenance expense is assumed to be $\rho=5$ per cent and 40 per cent of the total income. Moreover, the total income of water is considered as two kinds (the constant expense F and the charge according to the amount used) and sets to $F=\text{A\$}60\text{m}$. (The basis is the fact that City Water, one of the metropolitan retail water businesses, has paid a fixed cost of $\text{A\$}13.6\text{m}$ to Melbourne Water).

The theoretical relation of the sustainable case to the water rates w and the asset size K is possible is given by the following formulas:

$$w = \frac{M-F+\mu \cdot K}{H} = \frac{\mu \cdot K - F}{0.6 \cdot H} = \frac{(0.102342 \cdot K - 60) \cdot 10^6}{247680}.$$

When the real assets K of water service property become $\text{A\$}1833.5\text{m}$ and the fixed charge income F becomes $\text{A\$}60\text{m}$, if

water rates per 1ml are set to A\$513.30, it will be possible to realise a sustainable management (refer to Figure 8.1).

Moreover, in this example, the total income was A\$272.74m, depreciation expenses were A\$26.33m and finance charges were A\$137.31m. The ratio of the sum total of depreciation expenses and finance charges to the total income is 60 per cent. ■

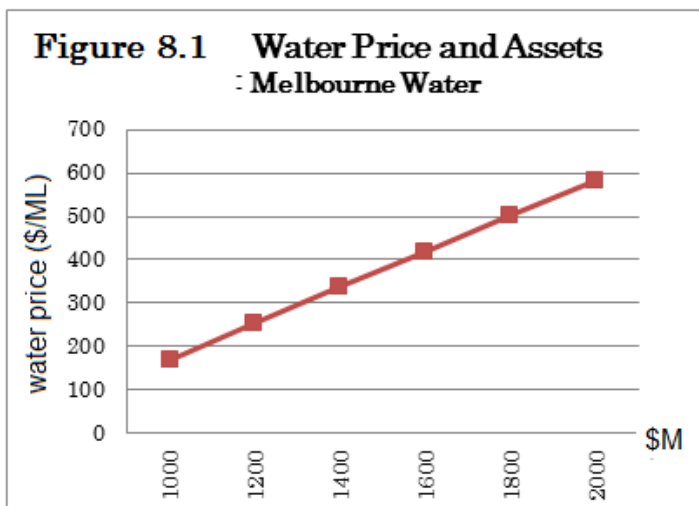
Then, what is the actual price of water? The income of Melbourne Water in the 2006-07 fiscal year was A\$187.3m (Melbourne Water, 2006/07, p.31). If we assume from the Melbourne Water data that the fee income is 72 per cent and a basic income is 28 per cent, the income by the amount of use changed to A\$326.68/ml when A\$134.856m was divided by the 412.8gl used in the 2006–07 fiscal year. Since this charge can be considered to be required to maintain about \$1400m of property, it can be said to be cheaper than a theoretical value as compared with this. Conversely, it can be said that the assets held as compared with income are large. However, as stated first, the setup of an actual water charge is subject to the influence of various risks. The main risks are:

- (1) price fluctuation
- (2) demand fluctuation
- (3) climate change, such as drought
- (4) sovereignty status, such as change of policy
- (5) contribution or donation to the environment.

Moreover, (6) socially vulnerable groups, probably also need to be considered. As these risk factors will be considered to be the factors in any rise in water rates if (6) is removed, if it is taken into consideration it can be said that actual rates are quite cheap.

8.1.3: Relationship between water property, and a net return and a water charge: second step

Next, we will consider final consumers' water charges. The water supplier (water utility) holds K property. It is assumed that this property reaches the time of updating all at once at present, and it will be presupposed that the loan was taken out at the long-term borrowing interest rate of r for T years. Moreover, the depreciation expense D is saved over T period by the deposit interest rate ρ , and suppose that funds equivalent to K are prepared after T period (sustainable case).



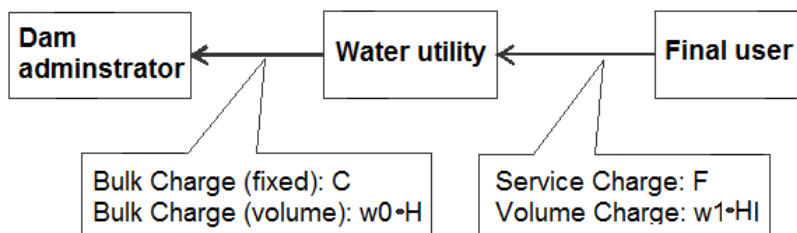


Figure 8.2: water pricing structure for final user

A water utility purchases water at the charge of w_0 per unit from a dam administrator and pays the constant expense C . On the other hand, a water utility sells water to an end user at the charge of w_1 per unit and receives the charge F of a fixed contract. Therefore, the water utility's annual income is stated as $w_1 \cdot H + F$. The water supplier's yearly expenditure to a dam administrator is $w_0 \cdot H + C$ as a bulk charge to cover the administrative and maintenance expense M , the depreciation expense D and the refund X per year. Furthermore, this water utility demands the profit rate π (or risk premium) from income $w_1 \cdot H + F$, and, further, if it is assumed as $M = m \cdot w_1 \cdot H$ ($0 < m < 1$), and $H(t) = H_0 \cdot e^{nt}$ ($0 < n < 1$), the following formulas must be created.

$$\begin{aligned}
 K &= \int_0^T \{ (1 - \pi) \cdot (w_1 \cdot H) + F - M - (w_0 \cdot H + C) - D \} \cdot e^{-rt} dt \\
 &= \int_0^T [\{ (1 - \pi - m) \cdot w_1 - w_0 \} \cdot H + (F - C) - D] \cdot e^{-rt} dt \\
 &= \int_0^T \{ (1 - \pi - m) \cdot w_1 - w_0 \} \cdot H \cdot e^{(n-r)t} \cdot dt + \int_0^T (F - C) \cdot e^{-rt} \cdot dt - \int_0^T D \cdot e^{-rt} \cdot dt
 \end{aligned}$$

$$= \left\{ \frac{(1-\pi-m) \cdot w_1 - w_0}{r-n} \right\} \cdot (1 - e^{-(r-n)T}) \cdot H_0 + \frac{F-C}{r} \cdot (1 - e^{-rT}) - \frac{D}{r} \cdot (1 - e^{-rT})$$

Furthermore, if (3) is used about D ,

$$w_1 = \left(\frac{1}{1-\pi-m} \right) \cdot w_0 + \left(\frac{1}{1-\pi-m} \right) \cdot \left(\frac{r-n}{r} \right) \cdot \xi \cdot \left\{ \left(\frac{C-F}{H_0} \right) + \mu \cdot \left(\frac{K}{H_0} \right) \right\} \text{ ----- (7)}$$

will be obtained. Here,

$$\xi = \frac{1 - e^{-rT}}{1 - e^{-(r-n)T}},$$
$$\mu = \left\{ \frac{r}{(1 - e^{-rT})} + \frac{\rho}{(e^{\rho T} - 1)} \right\}.$$

Example 3:

City West Water (CWW) supplies water to the end user in response to water supply from Melbourne Water. It is as follows when water-related data is extracted from the annual report for 2007 and 2008 (water supply service only. A unit is \$million).

	Symbol	Average 2005/06 to 2007/08	%
Revenue (water)	$w1H+F$	127.45	100%
Bulk water charges (fixed and variable)	$w0H+C$	48.42	38%
Operating expenses	M	35.16	28%
Depreciation	D	9.32	7%
Finance costs	X	9.40	7%
Profit	$\pi \cdot w1H$	25.15	20%

Table 8.3: City West Water P/L average from 2005/06 to 2007/08

(Source: created from CWW annual report 2007, 2008).

CWW supplies water to the end user in response to water supply from Melbourne Water. It is as follows according to water-related data taken from the annual report in 2007 and 2008 (water supply service only. A unit is A\$m). Using this data, 28 per cent of water service incomes is considered a basic charge income and 72 per cent is considered volume charges. It is therefore assumed as $w1 \cdot H = A\$91.73m$ and $F = A\$35.67m$. As the money CWW paid to Melbourne Water is A\$48.42m, if 72 per cent of that is considered to be water fees, it will be set to $w0 \cdot H = A\$34.86m$ and the constant expense $C = A\$13.56m$. On the other hand, because the annual consumption of water is 93gl, if the water fees are divided by this figure and it asks for water rates, it will serve as $w0 = A\$374.86/ml$. This amount of money is conformable as the price (i.e. A\$326.68/ml, refer to Example 2) of the water it is presumed Melbourne Water sold off.

On the other hand, how much are the water rates CWW collects from end users? 72 per cent of water service incomes (A\$127.4m) are water-rates income, and if divided by 93gl, $w1 = A\$986.71/ml$ is presumed.

Next, we will calculate a theoretical value. As the data show water service-related real assets are 3.46 times of annual earnings, they multiply A\$127.45m by this and assume it as $K = A\$440.98m$. Moreover, it is assumed as $\pi = 0.2$, $m = 0.3$, $r = 0.08$, $\rho = 0.05$, $n = 0.01$, and $T = 30$. It was set to $w1 = A\$1199/ml$ when calculated using (7) from this.¹ ■

To summarise, the results of the above example 2 and the example 3 are:

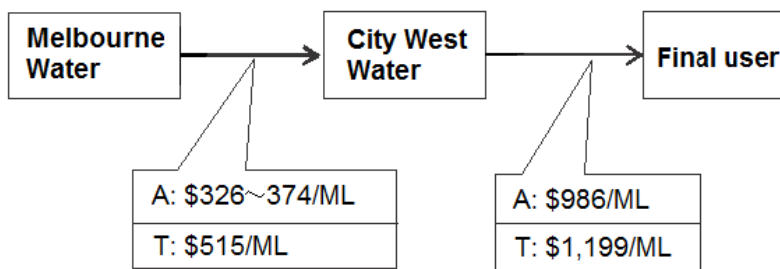


Figure 8.3: water cost structure, actual value and theoretical value

A of the upper row of the above column shows an actual price estimated from objective data, and T of the lower row shows the theoretical price.

If both are compared, it is actually 20 to 30 per cent of water price, lower than the theoretical value we calculated. We will examine the reason.

¹ Using a resident-oriented explanation, water rates are stated to be water service charges of A\$170.4/year and water usage charge A\$1785.4/ml in 2012 (refer to the CWW webpage, accessed 20 October 2012).

Table 8.4 compares the theoretical value of the income and expense composition of CWW with the actual value.

City West Water P/L		Theoretical		Actual	
Revenue		147.14	100%	127.45	100%
Volume	$wI \cdot H$	111.47	76%	91.78	72%
Fixed	F	35.67	24%	35.67	28%
Expenditure		147.13	100%	127.45	100%
Operating	M	33.44	23%	35.16	28%
Bulk Charge- volume	$wO \cdot H$	34.86	24%	34.86	27%
Bulk Charge- fixed	C	13.56	9%	13.56	11%
Depreciation	D	6.33	4%	9.32	7%
Finance costs	X	36.65	25%	9.4	7%
Profit	Π	22.29	15%	25.15	20%

Table 8.4: structure of CWW's P/L, theoretical and actual
(Source: created from the CWW annual reports for 2007 and 2008)

Although both have a similar general structure, an important difference is that the income value is actually nearly A\$20m lower. The reason for the lower income is that the finance costs are also lower at A\$25m rather than the theoretical value. The reasons are unknown, although perhaps it is due to the following points:

- Part of the property is not a debt but a governmental investment, or a subsidy, and there is no necessity for payment.
- The borrowing rate of interest is cheaper than assumed (8 per cent).
- The updating period of infrastructure is longer than assumed (30 years).
- The amount of the water used that becomes an income is less than assumed (93gl).

The reason for our examination was to check that the price of water mainly covers the expense of infrastructure. If the view is followed that infrastructure determines the main part of water price, we can understand the Australian water price roughly as follows:

The present irrigation agriculture price of water is around A\$16/ml. The price of tap water in cities (especially Melbourne) is at the A\$400/ml level and the price of a city (Melbourne) water supply contractor is at the A\$1000/ml grade in general.² And the water price of the actual water for cities will be affected by risk and social setting considerations, or by introducing two steps of progressive tariff systems.

² According to the RMW inquiry held on 7 September 2012, the average price of water of all the dams in the MDB was about A\$16/ml.

Now that we theoretically understand the factors that specify the water price, we will consider the argument at the policy stage for determining a more concrete water price.

Section 2: Pricing reform of NSW

Pricing reform for water is both an old and a new problem. This is because change on this level has a big influence on the use and distribution of water resources economically, socially and environmentally. The 2011 fiscal year report of the National Water Commission (which promotes present price reform) defined **pricing reform** as follows:

Overall, pricing reforms aimed to improve the economic efficiency of water use and the industry as a whole (e.g. investment, operations and asset management) including ensuring that consumers are protected from excessive prices in natural monopoly markets. In turn, efficient water pricing helps ensure that production and consumption decisions across a range of sectors and industries of Australia's economy reflect the efficient costs of water as an input (NWC, 2011e, pricing reform, p.x).

In Australia, pricing reform has a long history. The main reason is connected with the problem of the management expenses of MDB based on the agreement of each state. The problem of how

to pay for dam construction in the MDB, the administrative and maintenance expenses, the renewal expense of property etc. in between each state and the federal government was one important factor with a big influence on water price. Moreover, each state government needed various price reforms for promotion of the efficient utilisation of the water in irrigation agriculture and for the improvement of the water supply organisations' financial situation. Corporatisation and privatisation of the water supply organisations of the 1990s became an opportunity for big reform. As NSW was the first state to pursue such pricing reform, the pricing reform of NSW is considered here.

	NSW	Federal government
1980s	Measurement and metering charge of water are introduced based on Volumetric Allocation Schemes. 1983 Temporary water trading start 1989 River Operation Account: Two expenses are classified: Delivery Service Charge and Metering Charge. 1989 Permanent water trading starts	1987 MDBMC meeting begins to consider the cost allocation between three states.
1990s	1995 Interim new rural water policy towards cost recovery is introduced. Water management charges are added. 1995 Water reform package is	1994 COAG Water Reform Framework introduced 1998 The High Level

	<p>created. The examination is left to IPART (Independent Pricing and Regulatory Tribunal).</p> <p>1996 IPART presents five principles for pricing reform.</p> <p>1997 IPART introduces a simplified two-part tariff system</p> <p>1998 Permanent trade of water between states starts as pilot trial project</p>	<p>Steering Group for COAG's water reform is formed</p>
After 2000	<p>2001 IPART proposes reform.</p>	<p>2004 National Water Initiative was released</p> <p>2004 National Water Commission established</p> <p>2010 NWI releases pricing principle</p>

Table 8.5: the main occurrences of NSW water pricing reform
(Source: created from Governments documents and Martin, 2005)

8.2.1: The revised problem of the burden rate of the management expenses of MDB

In the River Murray Agreement of 1923, the expenses for management of the MDB (i.e. construction costs and operating and management costs) were distributed as 25 per cent each for the four governments (NSW, Victoria, SA, Commonwealth). When dam construction was controlled and the construction cost

decreased, the federal government's burden ratio decreased, but the distribution between the three remaining states remained equal until 1998. However, in 1998 the MDBMC determined a new burden rate based on and an analysis of the relation between costs and benefits and actual conditions. The burden percentage of the four governments was precisely defined for every item (refer to Table 8.6).

Decision basis	Year	Cost items	NSW	Vic	SA	Com
River Murray Agreement	1923	MDBC Works Construction Costs	25%	25%	25%	25%
		MDBC Works Operating and Maintenance	25%	25%	25%	25%
Murray-Darling Basin Ministerial Council Decision	1998	MDBC Works Construction Costs	30%	27%	18%	25%
		MDBC Works Operating and Maintenance	40%	36%	24%	0%
		Menindee Lakes Rental	30%	27%	18%	25%
		Menindee Lakes Rental Operating and Maintenance	55%	27%	18%	0%

Table 8.6: cost sharing between governments of MDBC expenditure

(Source: Martin, 2005, p.248)

A computer model was used to calculate the burden rate.

Naturally, changes in these burden rates become a factor affecting the burden of irrigation farmers.

8.2.2 Pricing reform of NSW from 1989 to 1995

Some important reform was carried out as a result of the MDBC's reexamination of cost allocation and the privatisation of Murray Irrigation (1995). The main aspects are as follows:

- Revision of licence fee: although the administrative expenses concerning the issue and updating of licences was covered by the licensing fee, it was not entirely covered. A new licensing fee was introduced in the privatisation of Murray Irrigation.
- Introduction of a metering charge in the Murray: as part of public sector reform, the Volumetric Allocation Scheme was introduced to the private diverters, and metering charges began to be collected with measurement being made compulsory.

Martin has stated as follows:

Metering charges were introduced in NSW to fully recover the costs of the monitoring the compliance of private diverters under the volumetric allocation schemes ... Prior to privatisation of the Murray Districts and Area, the department measured the water diverted into the districts and area by gauging of flows at the off-takes from the Murray system. There was no separate metering charge raised as the gauging costs were included in the operational costs in the district and area charges (Martin, 2005, p.251).

- Reform of the river operations account (ROA): for regulated river management, a river operations account is installed for every area. These accounts have accepted two incomes. One is the delivery service charge (DSC) and the second is a metering fee. The DSC covers 70 per cent of the activity expenses of the regional office and the office of a state government. According to Martin, the water price per year became determined by this reformed river operations account in the following process.

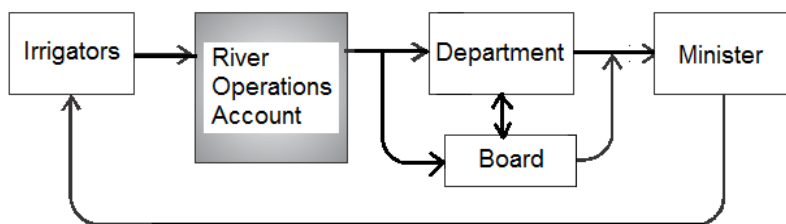


Figure 8.4: the process of water price determination by ROA

(Source: based on Martin, 2005, pp.251–2)

At the start of each season, the river operations accounts were presented to the NSW River Management Board for the Murray for scrutiny and advice. Departmental officers and the Murray River Management Board met to discuss the level of service to be provided and the cost forecasts of delivering the water supply services. These accounts were used as the drivers of efficiencies as the costs were exposed for the first time to the users. The department would make a submission to the Minister based on the following approved policy framework (as endorsed by Government), seeking approval for the water pricing to apply for the coming season. The board often made separate submissions to the Minister on the outcomes of the deliberations (Martin, 2005, p.252).

Moreover, for the following expenses, it is defined in principle who pays how much.

Items	Comments
Capital costs of major works	No cost recovery from water users.
Compliance management surveillance	Water user pays 100%.
Maintenance costs of major works (i.e. Hume and Dartmouth Dams, etc.)	No cost recovery from water users. However, for works used as means of diverting water for use by water users, an agreed share of the costs (i.e. weirs and off-take works).
Running the rivers	Water users met 70% of the costs through the DSC. The DSC comprised fixed and variable charges. Government met the remaining 30%.

Table 8.7: the principle of water cost burden

(source: created from Martin, 2005, p.252.

Note: *DSC=delivery service charge)

8.2.3 Pricing policy in 1995

In addition to the old DSC and metering charge, in September 1995 the NSW Government introduced a water management charge. This state-wide fixed charge asked for a burden of A\$1.35/ml of licenced entitlement right. This policy continued to the policy change (2001) by recommendation of IPART (Martin, 2005, p.253).

8.2.4 COAG reform and IPART

On the federal level, all the governments agreed with the February 1994 COAG water reform framework. This reform included a proposal for full cost recovery, reduction of subsidies, the problem of infrastructure renewal expenses, and water

charges for rural areas (refer to Chapter 1 and this chapter's Section 3 for COAG reform). In 1995, the NSW Government decided upon the original water reform package in line with the COAG principle. The examination of the price of water organisations is included in this package and the NSW Government left that examination to the NSW Independent Pricing and Regulatory Tribunal (**IPART**).

In October 1996, IPART recommended five principles as follows:

- Service efficiency – water charges should be based on the most efficient way of providing water services.
- Financial stability – the department's administration of water resources through the Ministerial Corporation should achieve financial stability and deliver a sustainable level of water services.
- Maximise community outcomes from use of water – pricing policy should encourage the best overall outcome for the community from the use of water and other resources to store, manage and deliver that water.
- Beneficiary and causer pays – those who are responsible for causing or benefit from those services should pay the cost of the water services. Those who cause more services to be required, or benefit more, should pay more.

- Ecological sustainability – pricing policy should promote the ecologically sustainable use of water and the resources to store, manage and deliver that water (Martin, 2005, p.254).

After this IPART was replaced with the conventional price system in 1997 and the two-step price system was proposed. This combined variable charges based on the amount of water used and fixed charges based on a licence entitlement. A more comprehensive reform based on impactor-pays or beneficiary-pays principle was introduced in 1998 (Pigram, 2006, p.67).

Price reform in NSW at the end of the 1990s brought about the increase of water charges according to the general view of a full cost principle. On the other hand, irrigation farms criticised the separation of the cost of the past nonperforming assets from the present user's burden. There was also criticism that the government should meet the expense burden that becomes the profit of the general community (Pigram, 2006, pp.67–68).

8.2.5 IPART's 2001 determination

As a result, IPART proposed the following reform in 2001:

- The improvement of the burden rate in NSW to the expense of MDBC.
- Although NSW Murray Valley had paid 95 per cent of those for the NSW burden of the expense of MDBC before, it was proposed that Murray should change to 70 per cent, Murrumbidgee should change to 29 per cent, and others should change to 1 per cent.
- Capping price increases – capped increases to 20 per cent for groundwater and unregulated systems and 15 per cent for regulated systems.
- Fixed and variable tariffs – progressive move to a two-part tariff (i.e. fixed and variable) in unregulated systems.
- DLWC/State Water cost recovery – state-wide the overall level of cost recovery (i.e. all valleys and systems) will increase from 61 per cent to 74 per cent (Martin, 2005, pp.254-259).

8.2.6 Conclusion of Section 2

NSW's pricing reform (especially in urban areas) reduced overall water demand by about 20 per cent and big improvements in water use and the river environment were found. As Pigram states:

The urban pricing program was essentially complete with almost all urban water providers applying transparent consumption-based pricing through a two-part tariff, and achieving full cost recovery.

Consumption-based pricing encourages more efficient water use and full cost recovery allows water providers to maintain and develop infrastructure. Consumption-based pricing also contributed to an estimated 20 per cent fall in demand for water by urban users (Pigram, 2006, p.72).

The price policy IPART defined is still used as the basis for calculating the charge for water users such as irrigation farms and city dwellers. Under such a structure water supply organisations (water corporations) that are a regional monopoly avoid the evil of monopoly and have secured transparency in pricing.

For reference we quote the water charges relevant to the main water supply organisations and plant (excluding urban areas).

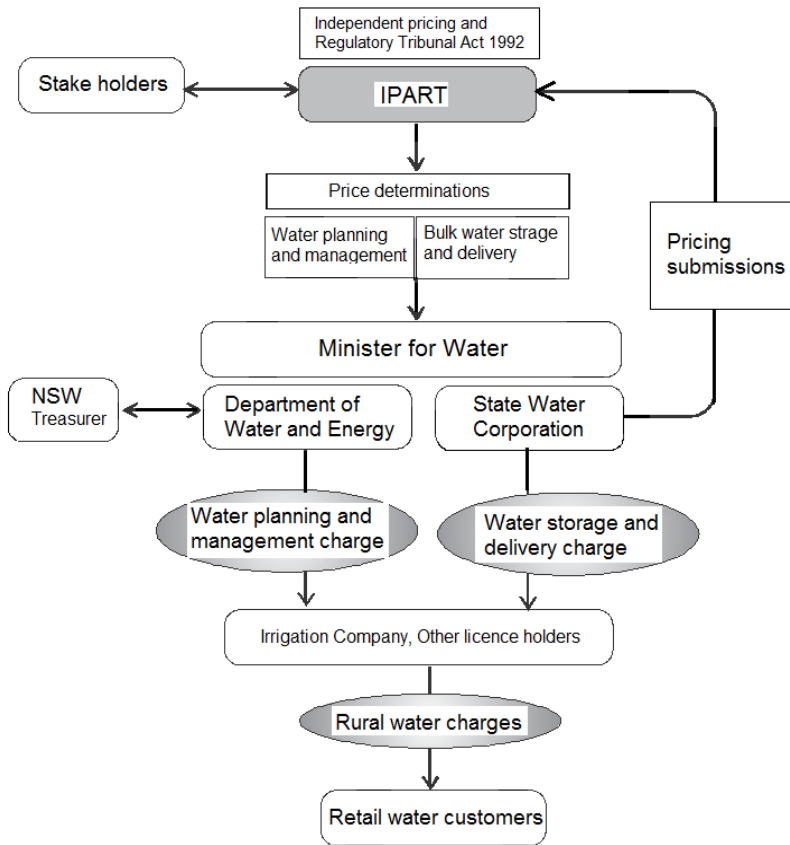


Figure 8.5: structure of water pricing rural water charges

(Source:

http://www.nwe.gov.au/_data/assets/image/0019/9406/nsw_rural_water_pricing.gif, accessed 25 October 2012, partly modified)

Section 3: Federal government pricing reform

8.3.1: COAG water reform package

The national strategy of 1992 and the announcement of the COAG water reform agenda led to price reform becoming a major issue for the federal government.

Although COAG consists of the federal government, the governments of the states and territories and the Australian Local Government Association, the federal government maintains overall financial control while pressing each state also to use financial control for reforms and also plays a role in forming a unified domestic market and strengthening the federal system.

The necessity for water resources management reform became part of the national strategy on ecologically sustainable development (ESD) in 1992. In response, COAG announced its Water Policy Agreement in 1994, raised the directivity of water reform and emphasised the importance of price reform or water rights reform. The COAG Water Policy Agreement of 1994 became a monumental document of water reform in Australia, and the impetus for all the states to play a positive part in water reform. The background COAG set for water price reform is explained as follows:

- use of water without regard to its cost of supply, leading to excessive consumption, and to environmental impacts and need for costly investments in new supply capacity, were left unchecked
- under-recovery of the costs of service provision and major asset refurbishment needs (particularly in rural areas) for which adequate financial provision had not been made
- service-delivery inefficiencies and a lack of incentive to provide reasonable levels of service at lowest possible cost
- commercial and industrial water users often paying far more than the cost of service provision (and cross-subsidising domestic water customers) because of property rates-based charges (NWC, 2011e, pricing reform, p.x).

There was another vector in Australian water reform: the viewpoint that it raises national global competitiveness.

National Competition Policy: in response to the Hilmar Committee report of 1993, raising the competitive power of industry was raised as a national goal. The public sector was criticised for lacking the required competitive environment to improve a customer service. In response to this criticism, COAG decided an improvement in economic effectuation was an important aspect of water reform (Pigram, 2006, p.65).

Therefore, COAG's water reform simultaneously pursued two goals: a water policy agreement and a national competition policy. This reform had an obligatory effect and was forced by the subsidy policy. The embodiment of water reform was defined by the Task Force on COAG Reform as follows:

- cost recovery and pricing
- institutional reform
- allocation and trading of sustainable water entitlements
- environmental aspects and water quality
- public consultation and education.

In this way, pricing reform, corporatisation, development of a water market, promoting environmental protection and citizens' participation in municipal affairs became a central subject not only at state level but also of the federal government's water reform. Of course, it was based on the success of Victoria and NSW, and an expansion of the water market was an underlying feature of COAG's water reform.

The organisation chart relevant to COAG's water reform is shown in Figure 8.6.

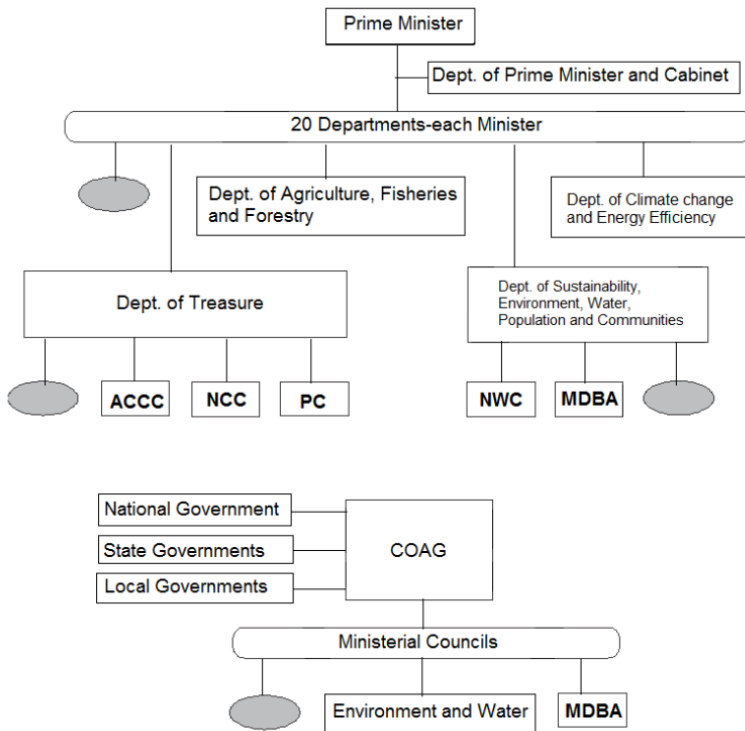


Figure 8.6: organisational chart of Australian Government and COAG
 (*NCC=National Competition Council;*ACCC=Australian Competition
 and Consumer Commission;*PC=Productivity
 Commission;*NWC=National Water Commission;*MDBA=Murray-
 Darling Basin Authority; source: created from government documents
 and web pages)

8.3.2 National Water Initiative

Although COAG's water reform produced big results in ten years, there were other aspects to it and the scarcity of water increased, requiring the continuation of further reform (Pigram, 2006, p.78).

Meanwhile, in order to advance further water reform, the National Water Initiative (NWI) was adopted in June 2004. Its purpose was as follows:

The objective of the initiative is to develop a compatible, market, regulatory and planning-based system for management surface water and groundwater resources for rural and urban use that optimises economic, social and environmental outcomes (Pigram, 2006, p.78–9).

This very comprehensive document appealed for water reform to be tackled over the following five years by each state and a territory i.e. the development of a permanent water market, the improvement of a water resources plan, the improvement of a water price, promotion of recycling, promotion of integrated management, reservation of water for the environment etc. Moreover, the National Water Commission was established as a promotional body to help carry this out.

Of particular importance on pricing policy was the 2004 National Water Initiative (NWI) best practice pricing and institutional arrangements' document that states:

- The NWI represents a shared commitment by governments to increase the efficiency of Australia's water use, leading to greater certainty for investment and productivity, for rural and urban communities, and for the environment.
- A stock-take on approaches to water charging was prepared by the Steering Group on Water Charges (SGWC) which identified three areas where differences in pricing approaches across jurisdictions were most marked:
 - approaches to recovering **capital expenditure**
 - approaches to setting **urban water tariffs**, and
 - approaches to recovering the **costs of water planning and management**.
- An additional set of pricing principles for **recycled water** and **storm water reuse** have also been developed to assist states and territories to meet their commitments under paragraph 66 (ii) of the NWI to develop pricing policies for recycled water and storm water reuse that are congruent with pricing policies for potable water.

- These four sets of principles are:
 - for recovering capital expenditure
 - for setting urban water tariffs
 - for recovering the costs of water planning and management, and
 - for recycled water and storm water reuse.

They are collectively referred to in this document as the NWI pricing principles.

- These principles have been agreed by Australian governments as the basis for setting water prices/charges in their jurisdictions. Governments agree that if a decision was made not to apply these principles in a particular case, the reasons for this would be tabled in parliament.
- A review of the NWI pricing principles will be undertaken in 2010 to ensure consistency between the pricing principles and the Commonwealth Water Act 2007, as well as take into account any further changes required as a result of COAG water reforms.

In addition, the National Water Commission (NWC) was installed as an organisation for attaining the NWI in December 2004. The NWC has three programs now: Water Smart Australia, Raising National Water Standards and Australian Water Fund Communities. Also, the NWC draws up various reports about the activity of the water market of Australia. And the NWI pricing principles were released in 2010 as the preliminary announcement. The contents are explained in full detail next.

8.3.3: 2010 NWI pricing principles

The Natural Resource Management Ministerial Council endorsed the National Water Initiative (NWI) pricing principles on 23 April 2010.

The NWI pricing principles were developed jointly by the Australian Government and state and territory governments to provide a set of guidelines or road map for rural and urban pricing practices and to assist jurisdictions to implement the NWI water pricing commitments in a consistent way.

The NWI pricing principles are comprised of four sets, including:

- (1) Principles for the recovery of **capital expenditure** to provide guidance to water service providers on asset valuation and cost recovery for urban and rural capital expenditure.
- (2) Principles for **urban water tariffs** to provide guidance for price setting in situations where there are monopoly providers and the absence of competitive pressures.
- (3) Principles for water planning and management to provide guidance, for urban and rural water service providers, in identifying and allocating the **costs of water planning and management activities** between government and water users.
- (4) Principles for **recycled water** and **storm water reuse** to provide broad policy guidance to stimulate efficient water use, in urban and rural settings, no matter what the water source (DSEWPC, accessed 25 October 2012).

Although 1 and 2 are not especially novel, in 3, the indicator about the assignment of the expense of a water management plan or management is defined between the government and water users. Moreover, in 4, the recycled water and the range of exploitation of water resources are expanded even to the reuse of storm water. It is thought that this indicates the future direction of Australia's water pricing policy. A further important

part of water price reform is that such price policies are common in all the states where such price policies have been agreed upon.

It is estimated that the price reform COAG promoted was eventually responsible for achieving reform at the state level. In particular, price reform enabled the conversion of the management technique from management of supply to demand and thereby the management of the aggravation of the water environment, the freeze on dam construction, the control of new water supply and the introduction of CAP. That is, it was shown that the price reform COAG advocated could perform water resources management by the market technique as a whole, and could serve as a new counterproposal by being interlocked with new techniques, such as the water market. It helped achieve increased efficiency for water supplies and had a big influence on the decision to further promote water reform with the NWI in 2004.

However, price reform for farming communities is still in progress. It seems that the collateral value of land fell due to the separation of land and water, resulting in irrigation farmers not being eligible for sufficient loans because property tax revenues applied to land decreased with the fall in the price of land. Although the seriousness of this problem is unknown, to solve it we will need to improve the collateral value and safety of the

water rights themselves. Pigram has described the progress of rural water pricing reform as follows:

[Feil's report (2004)] noted that rural water pricing reform was not as well advanced, with government-owned water business still having some way to go before achieving full cost recovery ... all jurisdictions have legislated to separate water entitlements from land, there is some disquiet in financial circles over the implications of 'unbundling' of water entitlements between access and use ... there is a perceived lessening of security on a financial investment that was based originally on land and water (Pigram, 2006, p.72).

Section 4: Summary and conclusions

Water price has an important influence on global competitiveness, such as of agricultural products, while affecting sustainable water resources management. As theoretical analysis shows, the main part of a water price is the expense (including finance charges) required for the maintenance and updating of water property, but in Australia the government has traditionally paid the renewal expense of water property to ensure agricultural protection. However, a beneficiary pays principle and full cost recovery was gradually introduced by the water reform of the 1990s and end users' burden percentage increased. Furthermore, water price policy

has been reformed gradually and continuously, expenses relevant to environment and plans concerning water resources management coming to be contained in the water price, and connected with the problem of expense burden between the state governments in connection with the water property of MDB.

NSW coped with the problem of water price by making a special mechanism (IPART) in which water price policy was deliberated and improving transparency, also introducing a policy of subsidies for water organisation management reform, administrative reform and agricultural protection in order to advance these price amendments smoothly. At the federal government level, the directivity of the NWI is accompanied, and water price reform is led, by the NWC presenting a common framework.

Although water price has risen gradually as a result of these reforms, water demand decreases as a result, and it is estimated that the efficient utilisation of water resources progressed as a whole. However, the NWC report of 2011 estimates that the latest drought threw the weak points of the water management of urban areas into relief:

While the initial pricing reforms focused on achieving technical or productive efficiency, the drought has highlighted shortcomings in the dynamic (investment) and allocative (sourcing and use) efficiency aspects of urban water management ... Inclining block tariffs are ineffective in managing variability in urban water supplies and place an inequitable burden on large households (NWC, 2011e, pricing reform, ix-xiii).

The water price level also has a big influence on the activities of a water market. For example, if the water price in a state rises, interstate trade may be activated. Moreover, the rise of water price also affects the efficiency of water use and agricultural technology development and the management of irrigation agriculture. Moreover, the problem of exit fees in a farming community affects the burden of the farmhouse management concerning the maintenance cost of infrastructure. The NWC report pointed out the problem of exit fees as follows:

In irrigation distribution networks, shifting fixed network access fees from entitlement-based charges to charges based on delivery rights, combined with the removal of exit fees, has helped the rural water market drive efficiency in water use and has facilitated adjustment in the MDB, without affecting the viability of irrigation businesses. Replacing exit fees with termination fees helps to manage the distributional impacts of decreasing customer numbers on remaining irrigation customers (NWC, 2011e, pricing reform, p.xii).

Thus water price reform, because it is mutually connected with water market reform, is considered to be an important component of Australian water reform.

Chapter 9

Environmental Policy and Management in Australia

This chapter and the following two chapters consider the relationship between environmental policy and management and water markets.

From the first, water markets set the pursuit of economic efficiency as their main purpose. This contrasts with environment management which sets the management of the negative effects arising from economic activity as its main purpose. At first glance, they look like estranged relations (i.e. a trade-off relationship) like water and oil, but both have united skillfully and have developed into a symbiotic mutualistic relationship like ‘a clownfish and a sea anemone’ in Australia.

In order to clarify more firmly such an interesting relationship, the trading of salinity credits is examined in Chapter 10 and an environmental flow is studied in Chapter 11.

Before going into a detailed examination, in Section 1 of this chapter considers the general relationship between a water market and the aquatic environment and presents the overall framework of the Australian aquatic environment and water resources management including a water market. Section 2 explains the institutional arrangement of Australian

environmental policy and management after the 1990s in relation to the development of a water market. This introduction to the environmental policy and environment management of Australia's water also serves as the premise for the following two chapters. Section 3 is a summary.

Section 1: Introduction

9.1.1: General relationship between water markets and the environment

When considering the relationship between a water market and the environment, we must generally analyse how the environment is seen from a water market, and how a water market is seen from the environment. It is necessary to unify both perspectives to provide a deeper understanding. However, when advancing this analysis, we should be careful of the following:

- (1) The size of influence on society differs between the two, qualitatively and quantitatively – like the relation between an adult and a child in size. That is, both should be understood as an asymmetric relation or as a source and derivatives.
- (2) The relationship between the legal system and the water market, and the relationship between water delivery

organisations and a water market are precipitate relationships and, so to speak, friendly relationships.

However, the relationship between a water market and the environment needs to be understood as including not only a precipitate but also a trade-off relationship.

While being aware of the above two points, we would like to consider the relationship of a water market and the environment generally, or more positively, to set up an analytic framework from the viewpoint of how a sustainable relationship between water markets and the environment should be built.

First, when the environment is seen from a water market, the environment is like the senior executive who has drawn the maximum amount of water (i.e. cap) which can be used by a water market. Moreover, supposing we desire coexistence with the environment, it can be said that environment has determined the range in which we work such as the zones in which it can trade, or gives or does not give permission for water trading based on a set of fixed rules. So to speak, the water market is allowed to act within the limits defined by the environment.

On the other hand, the water market seen from the environment has both a negative and affirmative relationship. With the former, the water market is only one of various factors that have a negative influence on the environment. However, the

water market must always be supervised for the influence the trend of a water market has on the environment (i.e. aquatic environment and biodiversity), since the treatment of water has a direct influence on the aquatic environment and river health; for example, where the use of water gained through the water market affects water quality and river flow volume and worsens the aquatic environment as a result. It may also happen when water trading of groundwater is activated and it, as a result, reduces the base flows to rivers. These are called the problems of environmental externalities (or direct effects). Moreover, when development of a water market affects the irrigation production, the rural community or the area, and other economic activities, it will have a negative influence on the environment as a whole indirectly through them (indirect effects). Refer to Figure 9.1.

In the latter, affirmative case, the market-based management technique may provide environment management with new scope. Salinity credits trading and environmental water purchase (environmental flow) through water markets are good examples of this. Furthermore, when new water resources development, such as dams, become unnecessary due to the development of a water market, it can be said that the water market has an affirmative influence on the environment.

As mentioned above, it is important for the fundamental relations of a water market and the environment to be understood not as a simple interdependent relationship but as a relationship containing a trade-off and a precipitate relationship. Moreover, it takes into consideration the understanding of it as a long-term relationship and also that a water market influences other activities, and the complexity of it is required to understand not only direct relations but also indirect relations (refer to Figure 9.1).

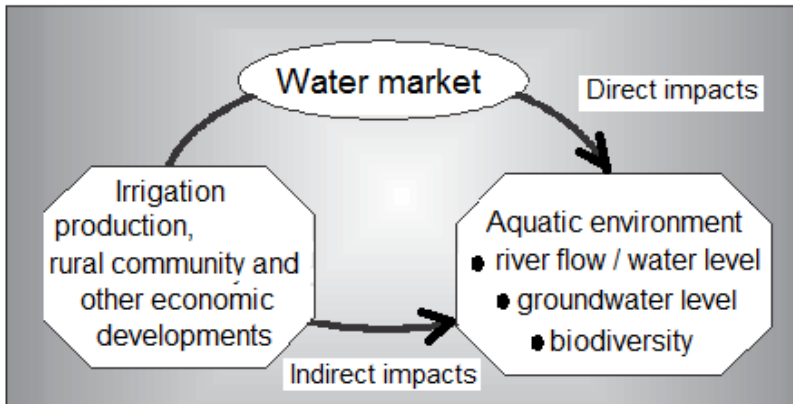


Figure 9.1: general relationship between water market and aquatic environment

9.1.2: Institutional arrangement of Australian water resources management and environment management

Next, we will show clearly what kind of structure is built for the management of the environment and water resources in Australia, especially focusing on institutional frameworks.

Under the Australian Constitution, the environment is the responsibility of state governments with regards to economic activity; they are also responsible for managing coexistence of the environment and economy. The federal government is involved in areas above the states. Therefore, in the Murray-Darling Basin (MDB), the federal government and state governments take executive responsibility and, in the areas other than the MDB, the state government takes executive responsibility.

The state government is responsible for both water resources management and environment management. In Victoria, management of water resources is called the sustainable water strategy which allocates water resources, including for the environment. It manages water distribution of urban, industrial and agricultural water. The water corporation takes the lead for each section or every area and the management of water resources is performed on the basis of this plan.

For environmental management in the state, there is another structure. An organisation called a **Catchment Management**

Authority (CMA) is established for every area, defines an environmental management plan and performs environment management. However, environment management and water resources management are not distinguished and both are intricately complex. For example, although the water corporation is obliged to supply minimum flow and to follow the limit of Cap, these are important also for the environment. The water corporation also moves the water between reservoirs for the environment under the Environmental Watering Plan created by not only each state government, but also the MDBA and federal government (refer to Figure 9.2).

In the case of the MDB, the federal government's administrative plan and the MDBA are related. RMW, which is one section of the MDBA, manages water resources of the Murray River in cooperation with state governments. It manages the distribution and the expense burden of the water resources of the Murray River in line with deliberations and agreements between states.

The natural-resources management section of the MDBA generalises the whole environmental management of the MDB, cooperates with the state organisations and manages the environment of the MDB.

Under the above it can be seen that overall administrative structure is constituted as follows (refer to Figure 9.2).

That is, in all states and the MDBA, there is a section with responsibility for water resources management and environment management. The MDBA and state governments cooperate at the MDB, responsible for both water resources management and environment management.

- (1) RMW, which is one section of the MDBA, has handled the flow management and water accounts of the Murray River, including the Hume dam, Lake Victoria, Snowy Mountain Scheme etc.
- (2) The environmental section of the MDBA cooperated with the CMA of each state, based on the *Water Act 2007*, imposing the creation and management of the Basin Plan (and also Environmental Watering Plan). And it performs the Living Murray Initiative, counter-salinity strategy and salinity register, Cap etc.
- (3) The water resources management section of the state creates the water resources management plans (in Victoria, these are called Sustainable Water Strategy, long-term water resources assessment, water resources management plan, etc.) and water-trading rules, zoning, water-market management (interstate trading included) etc. in collaboration with the water corporations.
- (4) The environmental management section of the state formulates various environmental management plans,

- including environmental flow, management of CMA, reservation of the water for environment etc. (including, in Victoria, the Victorian Environmental Water Holder).
- (5) Furthermore, although **Commonwealth Environmental Water Holder (CEWH)** is a special mechanism for securing the water for the environment, the Ministry of Environment manages and relates to the CMAs of each state following the **environmental watering plan** created by MDBA (refer to Figure 9.2).

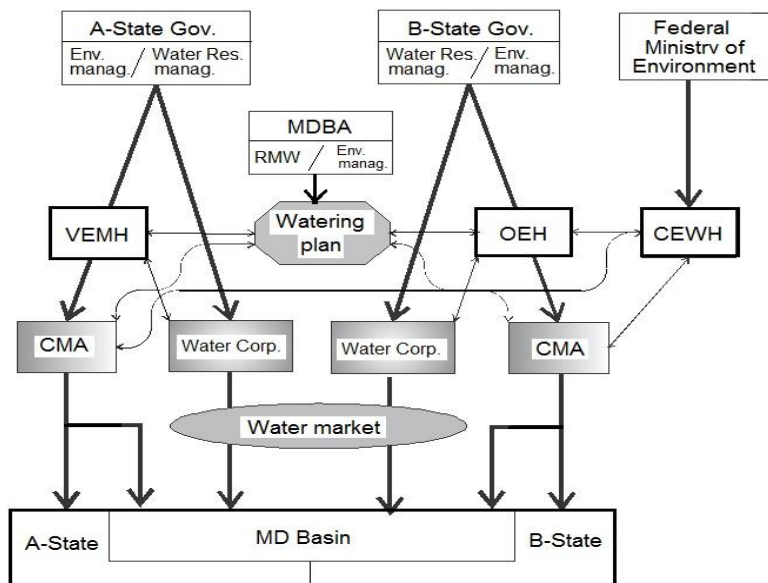


Figure 9.2: institutional arrangement of Australian water resources management and environmental management

(Note 1: Water resources management of the State of Victoria has affected the environment by controlling water corporations through the following means:

- (1) Management of minimum flow (or base flow) obligations**
- (2) Compliance of water trading rules**
- (3) Statement of Obligation set by the government, including environmental contribution charges* and seasonal watering statements (set by Victorian Environmental Water Holder)**
OEH = the Office of Environment and Heritage (NSW)
CEWH = Commonwealth Environmental Water Holder
VEWH = Victorian Environmental Water Holder

***Note 2: environmental contribution charges: for example, a water corporation in Victoria was called to subscribe 2 per cent of income from 1 October 2004 to 30 June 2008 for working out the expense of the environmental measure against the Living Murray Initiative, River and Aquifer Health programs, or others. (Of course, this expense was covered by the water charge). The total amount was set at A\$225m, and it is said that A\$35m was used for the Living Murray Initiative, and A\$18.5m was used for river aquifer health programs among them (PC, 2006, p.209).**

Note 3: In Victoria, VEWL exists as an NGO.)

The institutional frameworks of Australian water resources management and environment management differ for every state and are connected also with the principle of a federal system, and are quite complicated. However, in the MDB and also in state governments, there is a fundamental dual system of water resources management using water corporations and

environment management using CMAs. Furthermore, all the organisations are responsible to some extent for environment management.

Section 2: The institutional framework of Australian water environmental policy and management after the 1990s

This section briefly explains the institutional arrangement of the Australian water environmental policy and management after the 1990s. The following arguments are intended to guide the water environment policy and management of today's Australia.

9.2.1: Nationwide deployment of the environment policy and management after the 1990s

In the 1990s Australia's environmental policy was expanded from the state level and firmly established as a system applicable to the whole federation. Previously, there existed environmental organisations (in 1965, birth of the ACF), individual opposition movements (e.g. in 1967, the Save Lake Pedder Committee and, at the start of the 1970s, the formation of the Green Ban Movement etc.) and other environmental education activities. The environment became an important focus of national concern, especially with the advent of the Franklin Dam problem in 1983, the discovery of the ozone hole

in 1989 and the rise of global environment problems in general. As a result, the environmental movement and political reform began to interlock. The Hawke Government, which came to federal power in 1983, showed a big advance in respect of the environment policy and in 1992 created the National Strategy for Ecologically Sustainable Development of Australia. Australian environment policy greatly revolved around this. Thus it was in the 1990s that a system with a concrete national environmental policy was first established. The major developments in connection with water environment policy from 1992 onwards are briefly outlined.

	State	Federal and Others
1990s	1994 <i>Catchment and Land Protection Act</i> (Vic) 1994 The Hunter River Salinity Trading Scheme trial started (NSW) (The scheme was made permanent in 2002 and afterwards.)	(1992 Earth Summit) 1992 The National Strategy for Ecologically Sustainable Development of Australia 1992 Murray-Darling Basin Agreement 1994 COAG Water Policy Agreement- National Water Reform started 1995 Cap was introduced (MDBC) 1997 National Competition Payments (including Water Reform) started (1997–2004) 1998 River Murray Water (RMW) was established
2000s	2000 <i>Water Management Act</i> (NSW) 2001 Bush Tender program started (Vic)* 2002 Stream Flow Management Plans was released (Vic) 2003 <i>Catchment</i>	2000 Integrated Catchment Management in the Murray-Darling Basin 2001–2010 (MDBC) 2000 National Action Plan for Salinity and Water Quality (NAPSWQ) (COAG, 2002–08) 2001 Basin Salinity Management Strategy (BSMS) 2001–2015 started (MDBC, a part of Basin Plan) 2002 Living Murray Initiative started

	<i>Management Authorities Act</i> (NSW) 2005 <i>Water (Resources Management) Act</i> (Vic) 2007 Unbundling started (Vic) 2007 Victorian Water Register started 2007 Rivers Environmental Restoration Program (RERP) formed (NSW)	(MDBC, First Step: 2004–09) 2002 The National Market Based Instruments Pilot Program (NIMBIPP) started (a part of NAPSWQ, 2002–08) 2004 National Water Initiative was released 2004 National Water Commission was established 2004 Australian Government Water Fund (\$2 billion, 2004–10) 2006 Commonwealth supplementary contributed to the Living Murray (2006–11) 2007 <i>Commonwealth Water Act</i> 2007 National Plan for Water Security (\$10 billion) 2007 Water for the Future started (Cwlth, 2007–17) succeeding to National Plan for Water Security 2008 MDBA was established 2008 CEWH was established (Cwlth) 2008 Environmental Watering Plans started (MDBA, a part of Basin Plan)
2010s	2011 VEWB was established (Vic)	Late 2010 Basin Plan (guide) released (MDBA) August 2012 revised Basin Plan was released

Table 9.1: main occurrences in water environment policy after the 1990s

(*Note: although the bush tender program (Vic) is not directly related to water markets, it is a program of land management (biodiversity conservation) using a market-based instrument (MBI). This program can be considered one of the most successful programs in Australia for managing biodiversity outcomes using MBI and continues today. Refer to the example of B-2, 10.1.2 in Chapter 10 for details)

There are roughly two kinds of environmental problems connected with water resources management: the amount of water and the water quality.

The former is called the ‘over-allocation’ problem. For example, over-use of the river water by irrigation etc. based on the stabilisation of the amount of water by the dam in the Murray-Darling River, worsened the health of the river and caused the degradation of an ecosystem. This led to the introduction of the Cap system in 1995, the Living Murray Initiative in 2002, and the establishment of CEWH in 2008.

The latter type is a problem of salinity, which is not a problem in Japan.¹ This problem led to the establishment of the Hunter River Salinity Trading Scheme in 1994 and to the National Action Plan for Salinity and Water Quality (NAPSWQ) in 2000 and Basin Salinity Management Strategy (BSMS) in 2001.

Of course, these two problems are related and if damage from salt water aggravates, the amount of water that can be used will decrease. Moreover, if the flow of a river is securable, the salt concentration of a river is diluted and damage from salt water is eased.

The main policies introduced to cope with the over-allocation problem of water resources were Cap in 1995 and securing

¹ Section 1 of Chapter 10 explains the salinity problem in detail.

water for the environment (this was simply called environmental water reserve or environmental flow). Furthermore, a plan to use the gained water for the environment, called the environmental watering plan, was carried out by CEWH.

Steps taken to cope with the salinity problem are the salinity credits trading scheme of NSW and the salinity register of the MDBA. The water resources distribution plan of state governments adjusts the problem of the quantity and the quality of water resources as a whole at the state level. CMA environment management activity also plans and practises the integrative management of economic activity and environment at the state level.

At federal government level, the blueprint for pursuing water reform centring on a water market is the National Water Initiative of 2004, and the plan that materialised from this concept is Water for the Future with A\$12.9 billion invested over ten years. The promotional body for this water reform became the National Water Commission (NWC), and the Department of the Environment, Water and Heritage and the Arts (DEWHA).

Below, the important concepts and systems for understanding the water environmental policy and management after the 1990s are explained individually.

9.2.2: Environmental water entitlements

One of the premises for understanding Australian environmental water policy and management is accepting the legal rights of distributing water to the environment as well as to people.

These are called environmental water entitlements or **environmental entitlements**.

An explanation of how this operates in Victoria follows.

According to Section 48B of Victoria's *Water Act 1989*, the minister for water is responsible for supplying water to the owner of water rights or the owner of a licence. (This Act was amended in 2005 and enforced from 2006). The environment can also become a person concerned with water entitlements on a par with humans: the environmental entitlement.

S.48B(2) The Minister may allocate an environmental entitlement under subsection (1) for the purpose of:

(a) maintaining the environmental water reserve in accordance with the environmental water reserve objective;
or

(b) improving the environmental values and health of water ecosystems, including their biodiversity, ecological functioning and water quality, and the other uses that depend on environmental condition (*Water Act 1989*).

Environmental entitlements are defined as follows in such a legal framework:

- Environmental entitlements were included in the Water Act via the Water (Resource Management) Act 2005. The Water (Resource Management) Act 2005 amended the Water Act 1989 to create the legal foundation for water to be set aside to maintain the environmental values of rivers and streams. It is intended that environmental provisions embedded in existing bulk entitlements will be converted into environmental entitlements.
- An environmental entitlement is a right to water granted to the **Victorian Environmental Water Holder (VEWH)** for the purpose of maintaining an environmental water reserve or improving the environmental values and health of the water ecosystems and other users that depend on environmental condition. (<http://www.water.vic.gov.au/>, accessed 22 September 2012).

That is, this right is a special right only for a VEWH (VEWHs are discussed later). A VEWH is allowed to deal in these water rights, or to participate in an auction subject to various

restrictions. There were many arguments, for example, about the character of natural rights until this right was established legally.

We will, however, avoid deep involvement with the legal argument and simply establish that the environment is legally treated as a holder of the same equal water entitlements as people.

9.2.3 Water resource plans

The biggest problem in a water resources plan is probably deciding how much water should be secured for the environment. The incident that demonstrated the importance of this problem to the public was the introduction of the Cap system in MDB in 1995. Cap was introduced after it was recognised that over-exploitation of water resources by irrigation agriculture etc. reduced the flow of the river and made it lose natural dynamism, causing reduction of wildlife and fish and rising salt concentrations in rivers, lakes and streams. As the cause of such problems was over-allocation, the Cap was implemented so it could be restricted. Cap essentially handled the problem of how much water should be distributed for the environment.

Pigram describes the situation in the meantime as follows:

The Water Policy Agreement put in place by COAG in 1994, and endorsed by successive high level policy groups, signalled

a new urgency by state and federal government to pursue efficient, sustainable use of water in Australia. Foremost among the reforms was a commitment to allocation of water to the environment as a legitimate user of water. It is now widely recognised that a number of river systems in Australia are under stress and that there should be a better basis for protecting the environmental value of river systems, wetlands and estuaries. Not surprisingly, so-called 'green' groups are strong supporters of this approach, but rural landowners, townsfolk and city-dwellers are also generally in favour of providing water for environmental needs. Yet, the issue has become controversial and has emerged as a most difficult aspect of water reform. As with many conflict situations, the answer lies not in *what* is proposed to be done, but in *how* it is done. It is the process for allocating environmental flows to river systems that is flawed, not the policy itself (Pigram, 2006, p.155).

Water resource plans have determined the water resources distribution of each state as well as controlling distribution for the environment.

With a few exceptions, environmental flows are determined through water resource plans², which are prepared for surface water and groundwater sources. These plans are developed to meet a range of policy objectives that include

meeting the needs of environmental and non-environmental users. There may be a hierarchy of plans, with strategic plans providing a framework for more detailed operational plans, which cover the management of diversions and flows and may also govern the distribution of water. Plans are developed through a process of community consultation. Because scientific knowledge and community preferences change over time, most Australian jurisdictions have statutory requirements to undertake periodic reviews of allocations for environmental purposes (PC, 2006, pp.164–65).

- In NSW: the Water Management Act 2000 is the basis of the water resources distribution plan. Categories of water for the environment were divided as follows: minimum river flow, environmental health water, supplementary environmental water, adaptive environmental water (PC, 2006, p.165).
- In Queensland: water resource plans are established under the legal basis of the Water Act 2000.

² Statutory management plans developed for particular surface-water and groundwater systems, currently known by different names throughout the MDB (e.g. water sharing plans in New South Wales and water allocation plans in South Australia). Refer to webpages of MDBA- Glossary, accessed 22 September 2012.

- In Victoria: the legal basis is the Water (Resources Management) Act 2005 (PC, 2006, p.165). The long-term plan for the unregulated catchment level about water for the environment is called the **Streamflow Management Plan**³. Plans for emitting the water for the environment in the coming 12 months in regulated rivers are called **Seasonal Watering Plans**.

Next, at MDB, for the first time, the Living Murray Environmental Watering Plan gave the framework that determined water for the environment:

The Living Murray Environmental Watering Plan 2005–06 ... provides an operational framework for the application of environmental water. This water plan aims to manage competing environmental objectives between sites and includes a set of criteria to help make trade-off decisions (Murray-Darling Basin Commission, sub. 31, pp.3-4, as quoted in PC, 2006, p.140).

³ Streamflow Management Plans (SFMPs) aim to provide a balanced and sustainable sharing of available water between all water users in unregulated catchments. SFMPs are now recognised as management plans under the Water Act (as amended 2002) and are legally binding on individual water users and authorities. <http://www.gmw.com.au/policy/watermanagementplans>, accessed 4 October 2012.

Under the Living Murray Initiative, six icon sites are defined, water for the environment is secured and tests are carried out to help improve river environments. Scientific experiments are stepped up to determine the minimum water required for the environment. A special feature of Australian environmental management is adaptive management – an ongoing search for symbiosis with nature. It is a classic example in which failure is not feared and trial and error are repeated.

The Murray-Darling Basin watering plan was created based on the Intergovernmental Agreement on Addressing Water Over-allocation and Achieving Environmental Objectives in the Murray-Darling Basin of 2004 and the second intergovernmental agreement relating to the Murray-Darling Basin of July 2006. This provided the framework that determines water for the environment (MDBA, 2009, Progress Report on the Living Murray Initiative-First Step, Final Report, p.6).

The Basin Plan (proposal) released at the end of 2010 was obliged by the Water Act 2007 to formulate a plan for planned environmental water that included a water resource plan. Refer to 9.2.5 for details of the basin plan.

9.2.4: CMAs

The development of deforestation and irrigation agriculture has seen Australia suffer such environmental problems as erosion, deforestation, declining water quality and damage from salt water. Despite being at the centre of irrigation agriculture, the southern part of the Murray-Darling Basin suffered serious damage from salt water. The rise of the environmental movement of the 1980s meant it became impossible for the Victorian government to neglect this problem and it opted to introduce a new mechanism as a preventative measure.

This is the Catchment and Land Protection Act 1994. Using a basis of integrated catchment management, the government and community jointly formulated and set up a catchment environmental preservation plan. The Catchment and Land Protection Board (CALP-Board) was installed in ten regions of Victoria based on the 1994 Act. The Act was revised in 1997: the CALP-Board became catchment management authorities and the authorities' power was strengthened. This concept of integrated catchment management and the installation of CMAs then spread to NSW, Queensland, WA, SA and the Murray-Darling Basin. The right of taxation is granted to CMAs in SA. However, there is a big difference in financial strength, the range and other aspects of the CMAs in each state – a point that needs to be noticed (for the Murray-Darling Basin CMA, refer to Pigram 2006, p.170).

The following 10 CMAs now function in Victoria.



Figure 9.3: Victoria's CMAs

(Source: <http://www.dse.vic.gov.au/>,
accessed 29 December 2012, partly modified)

- Corangamite CMA
- East Gippsland CMA
- Glenelg Hopkins CMA
- Goulburn Broken CMA
- Mallee CMA
- North Central CMA
- North East CMA
- Port Phillip and Westernport CMA
- West Gippsland CMA
- Wimmera CMA

For more detail about Victorian CMAs⁴ refer to:

http://www.water.vic.gov.au/governance/catchment_management_authorities/your_local_cma.

9.2.5: Water Act 2007 (Cwlth) and Basin Plan

Water Act 2007

The Water Act 2007 came into force on 3 March 2008 and implemented key reforms for water management in Australia.

The Act establishes the **Murray-Darling Basin Authority (MDBA)** with the functions and powers, including enforcement powers, needed to ensure that basin water resources are managed in an integrated and sustainable way. The Act requires the MDBA to prepare the basin plan – a strategic plan for the integrated and sustainable management of water resources in the Murray-Darling Basin. Eventually the basin plan needs to be approved in Parliament. It has strong legal binding force, that is, once this basin plan has materialised, it has the power to restrain the plan of each state. Execution of the basin plan may change the role of the MDBC, which until now was a coordinated institution between the states, into a state government organisation. Connell describes this point as follows:

⁴ 11.5.1 provides an example of when the CMA and CEWH cooperated and carried out the environmental flow. For integrated catchment management refer to Ewing, 2003.

If a state fails to develop a satisfactory plan, the Commonwealth is empowered through the Water Act 2007 to develop its own plan for that state (Connell, 2011, p.334).

The Act also establishes a Commonwealth Environmental Water Holder (CEWH) to manage the Commonwealth's environmental water to protect and restore the environmental assets of the Murray-Darling Basin, and outside the basin where the Commonwealth owns water.

Moreover, the Act provides the Australian Competition and Consumer Commission (ACCC) with a key role in developing and enforcing water charges and water market rules along the lines agreed in the National Water Initiative (refer to Figure 8.6 for ACCC). And, the Act gives the Bureau of Meteorology water information functions that are in addition to its existing functions under the Meteorology Act 1955 (Australian Government, accessed 4 October 2012).

Basin Plan

The basin plan is described as the centrepiece of the Australian Government's water reform agenda. It aims to:

- set and enforce environmentally sustainable limits on the quantities of surface and groundwater that may be taken away from basin water resources---these are known as **Sustainable Diversion Limits (SDLs)**;
- set basin-wide environmental objectives, and water quality and salinity objectives ... to be set out in an environmental watering plan;
- develop efficient water trading regimes across the basin ... consistent with one of the principles of the NWI;
- set requirements that must be met by state water resource plans; and
- improve water security for all users of the basin's water resources.
- Once the basin plan is finalised by the MDBA and adopted by the Minister, it is to be tabled in both Houses of Parliament. However, as set out in the Water Act, the SDLs will not take full effect until 2014 for most states, and 2019 for Victoria, when existing state water sharing plans expire. Renewed water sharing plans will have to comply with the water management requirements of the basin plan (ANAO, 2011, pp.17–18).

In October, 2010, the MDBA released the *Guide to the Proposed Basin Plan*, which sets out proposals for key elements

of the plan. According to the *Guide*, basin-wide reductions in average annual water use of between 3000 and 7600gl were proposed (in the case of surface water see MDBA, 2010, *Guide*, pp.57–8). The amount of water required for the environment was calculated as follows. First, 2442 key environmental assets and 106 hydrological indicator sites are selected in the whole basin and the amount of water required to maintain certain flow regimes for each environmental asset is calculated. The amount of water required for the environment is calculated by deducting an overlapped part from here. This and the present amount used are measured and the amount of reduction is determined (for groundwater, it is fundamentally the same. The amount of reduction of groundwater is set to 99gl/y to 227gl/y). A summary of the basin plan is shown in Table 9.2.

	Environment		Humans	Interceptions	Comments
	Outflows through Murray Mouth	Environmental water	Watercourse diversions		
Current diversion limits	5,100	14,000	10,940	2,740	Current use on a long-term annual basis
Minimum Basin Plan	7,060	15,040	7,940	2,740	Reduction proposal of 3000 GL
Maximum Basin Plan*	10,180	16,520	3,340	2,740	Reduction proposal of 7600 GL

Table 9.2: summary of basin plan (gl/y)

(Source: based on Basin Plan, 2010, *Guide*, p.75, Figure 6.10.

Note: *This volume of reduction is based on a full range of forecast of reductions in surface-water availability due to climate change)

This proposal is revised in the first formal consultation document in November, 2011 which sets a long-term environmentally sustainable level of water taken from its rivers to 10,873gl. This basin plan proposes that 2750gl of them should be given to the environment (MDBA, 2011b, Plain English, p.vii). “Of this (2750gl/y), an estimated 1068gl/y has already been recovered for the environment through buyback and infrastructure improvement schemes and a further 214gl/y has been announced recently, leaving 1468gl/y to be secured” (MDBA, 2011b, Plain English, p.vii).

The legal basis of this plan is the Water Act 2007 (Cwlth). A central target as of 2012 is a 2750gl reservation of water from the Murray-Darling Basin for the environment. This is equivalent to 25 per cent of average total surface water use. However, the already secured water also is deducted, so water to be newly gained is 1468gl/y (MDBA, 2011b, p.vii).

Environmental organisations in general welcome this basin plan. However, there is a strong opposition in some rural areas which say that the scientific basis for a reduction is especially ambiguous, and the influence on rural communities is too great. Moreover, the reduction of water rights is not uniform. General

water security is more reduced and there is also the opinion that it is life-and-death matter for irrigation agriculture that depends on water. Also, they say is not clear who pays for expenses.

On the other hand, this basin plan has an epoch-making aspect in that it further expands and promotes the Living Murray environmental regeneration enterprises. Moreover, the new view of Sustainable Diversion Limit (SDL) was proposed instead of Cap.

In order to give the basin plan an innovative environmental meaning, Young has proposed changing SDL from a quantitative approach into an entitlement-based approach.

By taking an entitlement-based sharing approach and defining the environmental water requirement (EWR) as the portfolio of entitlements to be held for the environment in each region, accounting risks can be managed more effectively, the need to compulsorily acquire water in the future can be avoided and a more flexible approach can be taken to the resolution of the basin's problems (Young, 2011, p.444).

Although a part of this plan was the environmental watering plan, this portion was already practised through CEWH, regardless of whether the plan was enacted or not. On 26 October 2012, the prime minister announced the government

was adopting a more ambitious target, aiming to add a further 450gl of water to the stressed Murray-Darling river system by 2024. However, under the present circumstances, the prospect of this happening seems unlikely.⁵

9.2.6: Commonwealth Environmental Water Holder (CEWH)

CEWH held the water for the environment born out of the Living Murray enterprise etc., supplied water to the environment according to the environmental watering plan that was developed by the MDBA, and was installed as an enforcement organisation for preserving and recovering the environment in 2008. Administratively the CEWH comes under the federal Ministry of Environment. Its legal basis is Part 6 of the *Water Act 2007*.

CEWH is described as follows:

Commonwealth environmental water is actively managed to ensure that the maximum outcome is achieved from the available water. At any point in time, the options for managing water include delivering it to environmental assets within the current year,

⁵ Federal Environment Minister Tony Burke signed off on the basin plan on 22 November 2012 and it came into legal effect on 24 November 2012.

carrying over water to future years by leaving it in storage (where possible), or trade of water The use of Commonwealth environmental water is supported by a network of environmental water partners throughout the basin, such as environmental water advisory groups, catchment management authorities, state governments, river operators, scientific organisations and site managers. These partners are helping to manage Commonwealth environmental water by options for where it is best used, helping to deliver the water, and to monitor the outcomes.

(<http://www.environment.gov.au/ewater/>, accessed 22 September 2012).

As of 31 August 2012, the amount of water which CEWH holds on a title is converted into 1415gl, and the long-term average amount of water is 1023gl (refer to Table 9.3).

	Registered entitlements (ML)	Long Term Average Annual Yield (ML)
Total Murray-Darling Basin	1,414,995	1,023,159
-Southern Connected Basin*	1,015,244	840,169
-Non-Southern Connected Basin	399,711	182,990
-Qld	74,350	40,324
-NSW	776,700	467,649
-VIC	460,848	422,436
-SA	103,056	92,751

Table 9.3: holding water quantity of CEWH as of 2012

Note: *Southern Connected Basin entitlements include Murrumbidgee, Murray, Lower Darling, Goulburn, Campaspe (excluding Coliban) and Loddon titles.
 (Source: <http://www.environment.gov.au/ewater/>, accessed 22 September 2012)

9.2.7: Victorian Environmental Water Holder (VEWH)

VEWH was established in Victoria in July 2011 by the Water Act 1989 (Part 3AA). Its objectives are to manage the water holdings for the purpose of:

- (a) Maintaining the environmental water reserve in accordance with the environmental water reserve objective; and
- (b) Improving the environmental values and health of water ecosystems, including their biodiversity, ecological functioning and water quality, and other uses that depend on environmental condition (<http://www.vewh.vic.gov.au/>, accessed 22 September 2012).

The function of VEWB is: (1) to create an environmental watering plan for environmental preservation, (2) to acquire water for the environment (including water entitlements purchased in a water market), (3) to use effectively the water acquired according to the plan, and (4) to cooperate with CEWH, etc. The environmental watering plan is called Seasonal

Watering Plans (refer to 9.2.3 for Seasonal Watering Plan).

It is necessary to consult water corporations in each area to formulate the seasonal watering plan and water corporations have the further responsibility of actually delivering water for the environment according to the plan. The plan provides the Victorian environmental watering program, setting the priorities for where, when, how and why environmental water will be used annually.⁶

9.2.8 Eco-funds and environmental water managers

The fundamental technique for securing an environmental flow is purchasing and collecting the water entitlements for the environment at counter value from the owner of water entitlements. This is called an **environmental buy-back** and needs at least two systems to make it function. One is the mechanism of securing funds for purchasing the water, and the second is the existence of the manager who manages the fund and purchases water entitlements in a water market.

This **environmental manager** (or environmental water manager) is installed in the following four forms:

⁶ Refer to following web page for the newest seasonal watering plan of 2012-13. <http://www.vewh.vic.gov.au/news-and-resources/resource-library/seasonal-watering-plan>.

(1) The water manager for the environment is put on the existing CMA. There is an example in NSW, Victoria and SA (refer to PC, 2006, p.155).

(2) Other public organisations can install water managers for the environment. RiverBank was installed as a foundation for the NSW Ministry of Environment to purchase water for the environment. Moreover, each government invested in and established a company called 'Water for River' in order to change the water distribution of the Snowy River and River Murray system. CEWH and VEWH also need an environmental manager. Such public institutions also need to purchase water and therefore need environmental managers.

(3) Private organisations can also install water managers for the environment. The New South Wales Murray Wetlands Working Group is an environmental corporation with a community base. And the Waterfind Environment Fund is a private eco-fund installed by a water broker. An environmental manager is needed to ensure the practical use of funds by such a private organisations.

(4) There are also other examples. For example, although the asset manager installed by the Living Murray Business Plan managed six icon sites, they also needed the purchase of water entitlements (PC, 2006, p.156).

Thus, in Australia, environmental managers and/or environmental flow coordinators, who have relations with water markets on various levels, are being established.

In addition, when the water administrator for the environment intervenes in a water market, the ACCC does not assume the price had been fixed unfairly (refer to PC, 2006, p.154).

It is thought that an environmental manager's installation has the following meaning:

- It proves that the water market has the power to create a new system or produce a new program (ex. Living Murray Initiative).
- It proves that a water market is an effective means for environment management.

Although eco-funds or environmental funds are generally used for environmental improvement, water rights buy-back for environmental flows also apply. Buy-back of water entitlements needs a large amount of funds. Various organisations and institutions absorb these funds which are injected into the water market through environmental managers.

Government system funds and private sector system funds are roughly distinguishable.

First, there is the establishment of the foundation by the private company, environmental organisation, or community-

based group, which accepts the donation by the individual or companies (e.g. Waterfind Environment Fund, fund of New South Wales Murray Wetlands Working Group). Next, there is the establishment of the foundation by a government organisation (e.g. NSW RiverBank). Also, there is a public business corporation's establishment (e.g. Water for River). Furthermore, a government program (e.g. Water for the Future, Living Murray Initiative etc.) can be distinguished as a target of donation of funds.

These public or private funds are devoted to the purchase of water for the environment. In Australia, various kinds of **eco-funds** supply funds to environmental managers, utilise the water market and purchase existing water entitlements. The fact that these social relations exist are important when considering the environment policy in connection with water resources in Australia (refer to PC, 2006, p.153).

Section 3: Summary

This chapter examined the relationship between water markets and environmental preservation, and the environmental policy and environment management in Australia after the 1990s, especially focusing on the institutional arrangements.

Generally, the relationship between a water market (including salinity credits trading) and the environment has aspects both of

opposition and cooperation. In considering these relationships, it is necessary to note direct influence, indirect influence and short-term and long-term influences as discussed in Section 1.

In Australia, in order to achieve the two targets of simultaneous environmental preservation and industrial practical use of water resources, two management tools exist by way of water corporations and CMAs. For this reason, the negative influence on the environment by industrial activities, such as water markets and irrigation activities, are issues that can be eased or removed by other environment management means. Furthermore, various legal restrictions exist on the amount of use and the specific area of water resources, and this serves as an important precondition for the operation of market-based instruments. Moreover, computer modelling provides long-term predictions of causes and results of damage, and helps build structures and mechanisms to monitor environmental change. Section 3 of Chapter 10 and Section 4 of Chapter 11 explain this last point in more detail.

Chapter 10

Salinity Credits Trading

Although salinity credits (emission rights) trading is one form of a water market, this chapter considers the relationship of environment management and water markets through an analysis of salinity credits trading.

Section 1 explains Australia's salinity problem: the meaning of salinity, its history, its measures, and a theoretical framework of salinity credits trading. Section 2 considers the case of the Hunter River salinity trading scheme and Section 3 the case of the MDB salinity register scheme, respectively. Section 4 is the summary and conclusions.

Section 1: Australia's salinity problem

10.1.1: What is salinity?

Salinity is caused by the salt in the earth melting into groundwater by a rise in groundwater level (dryland salinity) or by salt being blown off the surface of the earth and into rivers (river salinity). Superfluous irrigation pulls up the groundwater level and serves as a cause of river salinity (refer to Figure 10.1). It has various bad effects on crops, the environment, drinking water, infrastructure institutions etc. This salt is derived from

ancient ocean sediments through the weathering of rocks, and has been deposited by rainfall in the sand over millions of years.

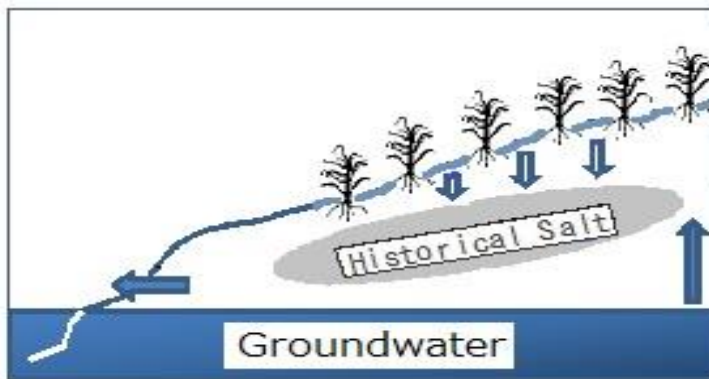


Figure 10.1: illustration of river salinity caused by irrigation
(Source: created by author)

If groundwater containing salt comes near 2 to 3 metres from the surface of the earth, groundwater will blow off on to the surface of the earth by capillarity, transpiration, etc. The groundwater level is changed sharply, not only because of natural precipitation but also artificial elements such as irrigation etc. The rise of the groundwater level by the use of irrigation and the damage it causes to agricultural products is called irrigation salinity. Effective measures against irrigation salinity are an increase in the efficiency of water-for-irrigation use, conversion of crops, change of irrigation location etc.

Dryland salinity is also connected with irrigation agriculture. For example, when annual crops and pasture not using much

water are planted instead of deep-rooted plants that use a lot of water, if natural conditions do not change, the groundwater level rises. A dam may also cause severe salinity: the dam's stabilisation decreases the flow of a river and weakens the dilution power of salt concentration.

If dryland salinity and irrigation salinity flow into a river, it will turn into river salinity. Therefore, to manage the salt concentration of a river, not only the river itself needs to be managed, but also dryland salinity and irrigation salinity.

The history of the measures against salinity is summarised in Table 10.1.

1890s	Problems of rising water tables and soil salinisation were detected after the establishment of the first irrigation schemes in the 1890s.
1980s	1987 Murray-Darling Agreement 1989 Salinity and Drainage Strategy (S&DS) signed by the Commonwealth, SA, Vic and NSW.
1990s	1994 The Hunter River Salinity Trading Scheme trial started (NSW). (The scheme was made permanent in 2002.)
2000s	2000 National Action Plan for Salinity and Water Quality (NAPSWQ; \$1.4 billion over seven years, 2002–08) 2001 Basin Salinity Management Strategy (BSMS)
2010s	Late 2010 Basin Plan (guide) released (MDBA) including water quality and salinity management plan.

Table 10.1: history of the measures against salinity

(Source: created by MDBC, 1999a, Salinity Audit, p.vi)

Salinity had already been generated from the first irrigation schemes undertaken in the 1890s. By 1987 it was estimated that 96,000 hectares of the basin's irrigated land were salt-affected, and 560,000 hectares had water tables within two metres of the land surface (MDBC, 1999a, p.vi).

Rising salinity levels in the River Murray and increasing land salinisation and waterlogging as a result of irrigation were important elements in the establishment of the Murray-Darling Basin Agreement in 1987. Salinity was one of the first major issues considered by the then new Murray-Darling Basin Ministerial Council and Murray-Darling Basin Commission (MDBC).

(http://www2.mdbc.gov.au/_data/page/114/MDB3614_Fact_Sheet_6.pdf, accessed 3 October 2012).

Near the Hunter River, a market-based instrument (i.e. salinity trading) was introduced for the first time in 1994, and succeeded as a measure against salinity. The measure against damage from salt water synthetically implemented under the BSMS was introduced in 2001 (refer to Table 10.1).

Future estimations of damage from salinity are as follows:

- The average salinity of the lower River Murray (monitored at Morgan) will exceed the 800 EC threshold for desirable drinking water quality in the next 50 to 100 years. By 2020 the probability of exceeding 800 EC will be about 50 per cent (MDBC, 1999a, p.vi).
- The Macquarie, Namoi and Bogan rivers will exceed the 800 EC threshold within 20 years, and exceed the 1500 EC threshold for irrigation crop and environmental damage within 100 years. The Lachlan and Castlereagh rivers will exceed 800 EC with 50 years. The Condamine-Balonne, Warrego and Border rivers will exceed 800 EC before 2020. The Avoca and Loddon rivers already exceed 800 EC on average. Some reaches of these rivers will rise to higher salinity levels again (MDBC, 1999a, p.vi).
- The 1999 costs functions study commissioned by the Murray-Darling Basin Commission found that under current conditions, the cost of one EC unit increase in river salinity at Morgan ... lies in the range of A\$93,000 to A\$142,000 a year. Already the total economic impact is estimated at A\$46 million a year and will rise further with the projected 330 EC increase over the next century. This study also found the cost to agricultural users, especially horticulturalists, is much higher than

previously estimated, while domestic and industrial costs are lower than previous estimates (MDBC, 1999a, pp.vi-vii. There are various presumptions about the amount of damage of salinity cf. Pigram, p.13).

- The indications of salinity to the irrigation agriculture are observed by 16 per cent of SA, 15 per cent of Victoria, 10 per cent of WA, 4 per cent of Queensland and 9 per cent of NSW (PC, 2006, p.216).
- More than A\$130 million of agricultural production is lost annually from salinity.

(<http://www.napswq.gov.au/publications/brochures/salinity.html>, accessed 3 October 2012).

Next, the relation between water markets and salinity is generally as follows:

(In the case of water entitlements trading)

Water entitlements trading has positive and negative influences on salinity.

- The negative influence is in cases that may cause a rise in groundwater level, when water moves and is used for irrigation by water trading in a specific area.
- Crops may be affected when water from areas where salt concentration is high is used for an area where it is low.

- The positive influence is when the downstream amount of water increases and salt is diluted when water moves downstream from upstream by water dealings.
- (In the case of salinity emission rights trading)
- If an appropriate framework is set up and emission rights management is appropriate, damage from salt water will not be worsened.

10.1.2 Measures against salinity

There are various methods to combat salinity, such as through engineering and the use of market-based instruments. These are divided into three types: regulation, hybrid and market-based.

The market-based method is a policy instrument that uses the incentives of a private economic player, guides change of spontaneous selection action and makes results of requests profitable. Although cap and trade is the main type, the introduction of a rate system, change of charges, introduction of a subsidy (or tax), bids, auctions and eco-labelling are also included in a broad sense in the market-based method.

10.1.2.A: Regulation methods

A-1: Plan and regulation

Plans for measures against salinity are formulated hierarchically from a federal level to an irrigation district level. By regulating the actions of economic players salinity is prevented or eased.

- National Action Plan for Salinity and Water Quality (NAP) – at federal level

This plan commits A\$1.4 billion over seven years to June 2008 to support action by communities and land managers in 21 highly affected regions. It supports practical remedies such as the protection and rehabilitation of waterways, improvements to native vegetation, engineering works, and land and water use changes (<http://www.napswq.gov.au/>, accessed 1 October 2012).

- Murray-Darling Basin salinity management strategy – at MDB level.
- State salinity strategies (SA, Victoria, NSW) – at state level.
- regional salinity or catchment management plans – at CMAs and water utilities level (PC, 2006, p.219).
- Land and water management plan – at irrigation district level (refer to McClintock & Young, 1996).

A-2: Salt interception schemes

Engineering measures called **salt interception schemes** against damage from salt water are considered the best solution.

Based on the land and water management plan described in A-1, the government and water utilities pay for them (the costs eventually passed on to irrigation farmers), and drains are constructed and/or updated to guard against salinity. It is a measure against salinity to stop floods from water supply institutions, or to physically intercept outflows of salt water from the river. Moreover, salt water is pumped up and passes to a river (especially in winter, with a great amount of water), or it may be piped to a specific place to evaporate. Furthermore, salt water is reused by mixing salt and fresh water.

Although these steps are instantaneously effective and there is durability of effect, it is at a high cost. (It is supposed that reduction of 1 EC will cost A\$2–3m). In the MD Basin, River Murray Water is participating in this enterprise.

(Example) 17 salt interception schemes are carried out and web pages of the MDBA say that about 500,000 tons of salt a year are now removed from the MD Basin.

Refer to the basin salinity management strategy annual implementation report for each year for details (<http://www.mdba.gov.au/water/water-quality/salinity>, accessed 4 October 2012).

A-3: Tree planting as a measure against salinity

Planting trees, or decreasing the recharge of groundwater, is effective in preventing water containing salt from flowing into a

river. Conversely, it also decreases the amount of water in a river, weakens the dilution power of a river and may worsen damage from salt water. Therefore, choosing where to plant trees becomes important. In addition, tree planting has various effects, such as prevention of soil corrosion, reduction of an area's low submersion under water by easing the outflow water to a river, and reduction of carbon dioxide.

A-4: Salt discharge in a river

Trials of pouring high-concentration salt water intentionally into the ocean were not performed. This was to avoid influence on the city downstream, and for not exceeding the target EC at Morgan.¹

However, when there is much water in winter, it is possible for each state to cooperate and to pour high-concentration salt water into the ocean, subject to concentration and timing. This decreases the total amount of salt, is cheap and agrees with environmental requirements (i.e. a natural state is imitated and a high water level is maintained in winter). Moreover, it is a dormant period of irrigation so there is little influence on irrigation in winter.

¹ For example, although Adelaide in SA depends on the River Murray for 40 per cent of the water used on average, this becomes 85 per cent in times of drought. The management target of the salt concentration of the River Murray is suppressing the EC in Morgan in SA to 800 or less.

Although this method is fundamentally an engineer's work, the market-based instrument can also support this enterprise. For example, when water for dilution is purchased from a water market and salt water is poured into the ocean, it can be said to be a hybrid form of the regulation technique and the market-based instrument.

Example: Salt flushing in Lake Charm

Although Lake Charm is a shallow natural lake located between Kerang and Swan Hill in Victoria, natural circulation was lost due to construction in the 1960s and high concentration salt water (which reaches 5000 EC) was generated. A Kerang-Swan Hill salinity management strategy was implemented to deal with this. A\$1.4m was provided in 1997 and a salt flushing operation was prepared. The target was to stabilise salt concentration to 2500 EC in 15 years. The entity in charge of this plan was the North Central Catchment Management Authority. G-MW took charge of the construction and operation of the salt flushing.

This project was positioned as part of the plan (Schedule C) of the Murray-Darling Basin Agreement. It was also an enterprise that gives the Victoria a salt credit of 0.47 EC on Register A.²

² The details of the salt credit scheme are mentioned Section 3 of this chapter.

Eventually, a total of six salt flushing events in the River Murray occurred over three intervals:

- twice between 28 September to 9 October 1998 for a total of seven days
- three times between 6 September to 7 November 2000 for a total of 43 days
- once from 28 August to 5 September 2003 for eight days.

However, part of the plan could not be carried out because of the drought in 2003 and afterwards. 4844ml of water were used and the salt of 12,000 tons was emitted to the ocean by these six discharges. However, this quantity remained 55 per cent of the plan from the first. A performance review in 2005 proposed a reexamination of operation rules, monitoring and reporting (PC, 2006, p.253).

A-5: Other means

There also exist the following regulatory methods against salinity:

- conservation farming (minimal tillage cropping, precision farming)
- use of deep rooted plants (ex. lucerne [alfalfa], salt bush, farm forestry) to minimise the rise of water tables to unacceptable levels

- revegetation management (fencing off areas for protection)
- storage of surface run-off in dams
- reusing drainage waters for irrigation
- improved irrigation efficiency and better delivery systems, such as drip irrigation

(<http://www.mdba.gov.au/water/water-quality/salinity>, accessed 4 October 2012).

10.1.2.B: Hybrid method of regulation and MBIs

B-1: Zoning and Levy

A salinity zoning scheme has been adopted by the Victorian Government to implement water trading and the salinity management provisions of the River Murray water allocation plan (PC, 2006, p.223). There are four types of **low impact zones** (LIZ 1-4) and one **high impact zone** (HIZ).

When water is imported in a high area from areas where salt concentration is low a surcharge is imposed to guide an irrigator so that water may be purchased from the equivalent or low area of salt concentration and water may be used.

Or dealings with specific zones are forbidden. These incomes are used as a fund for salt interception schemes (refer to Figure 10.2).

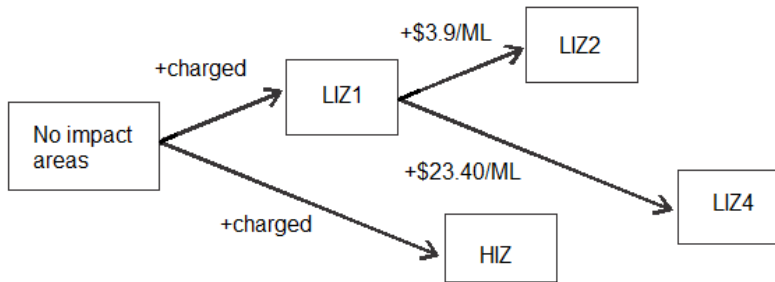


Figure 10.2: measures against salinity by zoning and levy
 (Source: created from PC, 2006, p.224)

The effect is considerable. By changing the flow of water trading, the salt of the Kerang-Pyramid Hill-Boort area was measured at the Morgan point and registered a reduction of 20 EC. The PC report said this result – achieved by combining zoning and a levy – was substantial compared to the reduction of only 6 EC achieved under through the national action plan for salinity and water quality. Although SA has also set up the zone, levies were not introduced but the irrigation development in the high salinity impact zone is subject to an offset requirement (PC, 2006, pp.224-5).

B-2: Offset and tender

When downstream damage from salt water is worsens because of upstream agricultural activity, this is the method used by the government to supply a subsidy to activity related to an upstream salinity outflow in order to reduce the discharge of salt

into the river. In that case incentives are used to change an upstream farmhouse's activity.

Example: Bush tender process in Victoria

The Victorian government explains what kind of influence (damage) the present method of irrigation agriculture of upstream has had downstream, shows the method for easing the damage, possible choices and their effects, and makes an upstream irrigation farmer choose the method by which a salt outflow is controlled (**offset**). To provide irrigation farmers with incentives, a reward is added to all methods and the farmer selects the most suitable method and notifies the amount of reward required. The amount taken from each irrigation farmer is chosen competitively. Therefore, the government input has a big effect and expenses can be minimised by choosing cheap tenders. It is especially effective when upstream irrigation farmers are scattered over a wide area and when it is difficult to carry out direct negotiation for upstream representation and downstream representation (i.e. when the transaction cost is high). However, this method requires funds for creating the degree of incidence and choice of environment (PC, 2006, p.249).

A program called **EcoTender** is also following the same line of thinking in Victoria. The difference between the two is explained as follows.

The **BushTender** assessment focuses on the environmental improvements to native vegetation whereas EcoTender includes riverine health, salinity, carbon and water quality. Both approaches collect the same information for use in the tender assessment.

(http://www.dse.vic.gov.au/_data/assets/pdf_file/0006/98034/Tender_based_ecoMarkets_Information_Sheet.pdf, accessed 7 October 2012).

These trials have the special feature in that the contract for environment management has attained the level of individual private land, thereby including action on an individual level in environment management. Furthermore, the subsidy method of distribution has the special feature of using the market technique (incentive) of a competitive bid.

10.1.2.C: Market Based Instruments method (MBIs)

C-1: Salinity credits (emission rights) trading

Section 5 and Section 6 explain this anew.

C-2: Emission rights trading of groundwater net recharge

This is a strategy that tries to prevent an increase in salinity by setting emission rights to the water drained into groundwater

aquifers, and managing it. The Coleambally Irrigation Co-operative is an example:

Example: Coleambally net recharge scheme

This enterprise gets funds from the national action plan on salinity and water quality, and experimented as one of ten enterprises in the national market based instruments pilot project.

First, the total net recharge amount of water was decided (cap). Ownership was allocated to this share, assigned to each irrigation farm, and trades were permitted (trade). This enterprise developed software that estimates the relationship between an individual economic activity and the groundwater recharge, and uses this to trade. Attention was drawn to the application of the market method to dealings at the small level of an individual irrigation farm, instead of previous dealings over a much broader area.

Although it was expected it was possible to achieve improved efficiency and flexible correspondence, the closeout report of July 2005 showed the rise in net income by C&T was only 1 per cent or less in 20 years. This enterprise was not continued (PC, 2006, pp.224–6).

(<http://www.marketbasedinstruments.gov.au/WhatisanMBI/TypesofMBIs/Capandtrademechanisms/Coleambally>, accessed 3 October 2012).

10.1.3: The theoretical framework of salinity credits trading

The concept of salinity credits trading or salinity emission rights trading is fundamentally as follows.

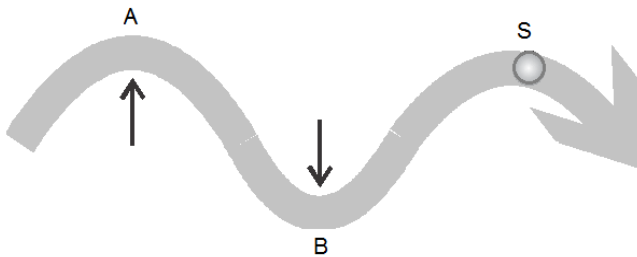


Figure 10.3: illustration of salt credits trading

(Source: created by author)

The administrator of a river will presuppose it is necessary to manage the salt concentration of the river to a certain point S (standard point) in a certain standard value for reasons of potability, environment etc. Since the flow of a river changes with precipitation, displacements etc., the salinity that can be discharged at the point S in a fixed period (for example, one day) changes every moment. Thus the salinity that can be discharged at a standard point is calculated from the data of old precipitation, the flow of a river, salt concentration etc. (For this calculation, investigation of causal relationships and development of software are required). The total frame of the salt which this salinity will hit for one day and can discharge in this river will be set to X (cap).

Next, persons A and B presuppose it is necessary to drain X_1 and X_2 tons of salt in a river one day as a result of an economic activity. We consider the case where $X_1 + X_2$ is more than X . In this case, each amount of discharge must be reduced so that $X_1 + X_2$ may not exceed X . The direct regulation method is calculated α as $\alpha = X / (X_1 + X_2)$, and the management authorities assign $\alpha \cdot X_1$ to A and $\alpha \cdot X_2$ to B as salt loads that can be discharged at specific points. An economic player cannot determine the amount of discharge by themselves and this method will perform an economic activity requiring the authorities' permission. As a result, when each player's opportunity costs (net return which has probably been gained if one ton of salt could be discharged) consider it as Y_1 and Y_2 each per ton, A will receive the loss of $(1 - \alpha) \cdot X_1 \cdot Y_1$, and B will receive the loss of $(1 - \alpha) \cdot X_2 \cdot Y_2$.

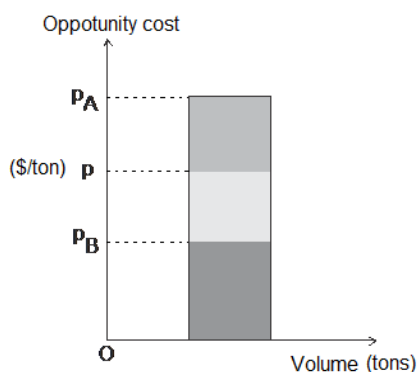


Figure 10.4: illustration of a win-win solution to the salinity problem
(Source created by author)

In this case (i.e. $\alpha \cdot X_1 + \alpha \cdot X_2 = X$), is there not any method of improving an economical position for both sides? Suppose emission rights trading was introduced and the opportunity cost (for each unit of salt discharged) of A is higher than the opportunity cost of B ($Y_1 > Y_2$). At this time, a right is set to discharge salt and that right makes dealing possible. Then B can sell his right to emit salt to A. If the price p of the right to emit salt is more than p_B when B sets to its opportunity cost $p_B = Y_2$, B can obtain the profit of $p - p_B > 0$ from these dealings. On the other hand, if the price p of the right to emit salt is below p_A when A sets to its opportunity cost $p_A = Y_1$, A can obtain the profit of $p_A - p > 0$ from these dealings. Fig. 10.4 illustrated the case of $p_A = Y_1 > p > p_B = Y_2$.

If free negotiation between the parties decides the emission rights price p is desirable, both sides can profit by dealing one unit of emission rights. Furthermore, only $(p_A - p) + (p - p_B) = Y_1 - Y_2 > 0$ can make both economical net-earnings totals increase by dealings between the economic units of a right of one unit economically without the total amount of emission rights changing. (Speaking economically, assignment of the amount of discharge by direct regulation was not the Pareto optimum and C&T can lead both parties to the Pareto optimal state).

As for the method of emission rights trading compared with direct regulation, firstly the management is independent, so that discharge of salt is controllable by its management decisions. Second, the total amount of an economic activity (sum total of net return) is maximised under fixed salt discharge restrictions. However, it is necessary to calculate the salinity which discharges by itself in a timely manner to actually operate emission rights trading, and an efficient market for emission which forms emission rights trading is needed. This means that fixed initial expenses are needed for the construction of emission rights trading or C&T.

Section 2: Hunter River salinity trading scheme

10.2.1 Target and governance

Let the second biggest city of NSW, Newcastle, be an exit for the river, the 22,000-square kilometre plain of the northeast is the Hunter River drainage basin catchment.

In this drainage basin there are more than 20 coal mines, including the world's largest coal mine, three power plants, and irrigation agriculture (wineries, dairying, vegetables, fodder, beef and horse breeding). Although the private producers' interests had been opposed to each other over many years in the Hunter River region, the Environment Protection Authority (EPA) proposed a market-based strategy instead of a conventional regulation method. The former Department of Land and Water Conservation (DLWC) took charge of

management of the river, developing modelling required for enterprise execution. The experimental enterprise was undertaken from 1995 to 2002, the Act³ was enacted in 2002, and it became a lasting enterprise.

In order to undertake this enterprise, the Hunter River Salinity Trading Scheme Operations Committee (HRSTS) was formed, and the Hunter Catchment Management Trust was also formed as an organisation of the stakeholders who further superintend that enterprise.

Participants in this enterprise are required to obtain a licence from the EPA. A duty of discharge points and monitoring and reporting requirements etc. are imposed upon the licence holder.

A standard point is installed in the town of Singleton and the target is set as 900 EC. The total amount of salt discharge credits is 1000 and one credit means 0.1 per cent of distribution. 200 credits are sold at auction every two years. A credit is valid for ten years. Initial credit-holders were 21 organisations and these were all company organisations except for the EPA.

Next, the governance structure is shown in Fig. 10.5.

³ The Protection of the Environment Operations [Hunter River Salinity Trading Scheme] Regulation 2002.

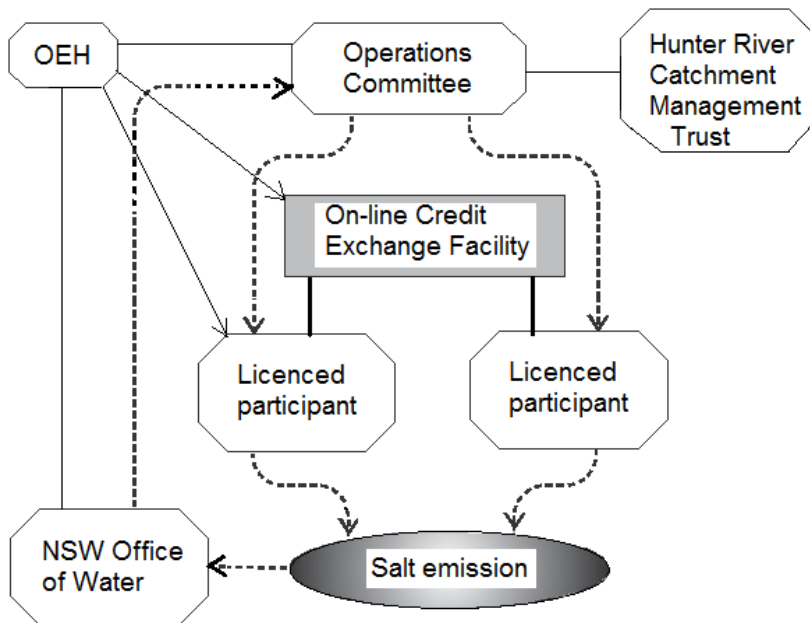


Figure 10.5: architecture of Hunter River Salinity Trading Scheme 2012

(Note: Office of Environment and Heritage (OEH) – licensing and regulation, and online credit register and exchange facility; NSW Office of Water – river monitoring, modelling and the river register. A solid line shows an administrative relationship (cooperation or supervisory) and a dashed line shows the flow of information.

Source: created by author based on

<http://www.environment.nsw.gov.au/licensing/hrsts/reference.htm>

accessed 10 October 2012)

10.2.2: Mechanism and management

Divide the Hunter River into three sectors. In the upper sector, when the flow becomes 1000 or more ml/day salt water can be

discharged at the previously agreed discharge point. Similarly, when it becomes 1800 or more ml/day in the middle sector and becomes 2000 or more ml/day in the lower sector, salt water can be discharged at the previously agreed discharge point. The river is divided as a block according to the distance it moves during one day. The salt concentration of a certain block (A) is calculated at a measurement point. Then, the salinity total amount discharge which may be passed to the block A is decided by a discharge point. This is set to X. (X is called Total Allowable Discharge Daily). This X gives the maximum of the amount of discharge. X is calculated so that the salt concentration of a standard point may not exceed 900 EC. The credit holder can discharge salt to its credit c at the discharge point which was able to define beforehand the salt calculated by $c \cdot X/1000$ (refer to Figure 10.6).

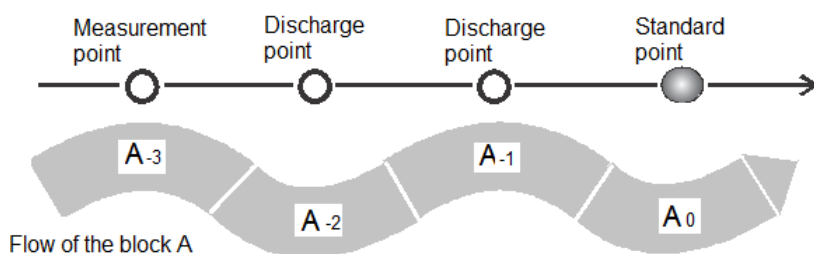


Figure 10.6: water block and management points

(Source: created by author)

When a credit is required for the credit holder, it can be purchased through a market. Each discharge unit can discharge salt water stably by the ratio of a credit except for cases where there are extremely low river flow rates every day. A premise of this mechanism requires the natural condition that the water of a river is moving comparatively slowly.

Next, monitoring, register and an online trading system are built as follows.

- A services coordinator manages the information that underpins the scheme. Twenty-one monitoring gauges collect information along the length of the river. Every 10 minutes measures of river flow and salinity are collected then sent by radio or phone to the central data warehouse.
- River modelling experts use this information to calculate the total allowable discharge in response to changing river flow and rainfall within the catchment area.
- A daily river register is maintained on a dedicated website. It notifies each credit holder about the amount of salt that can be discharged, and the start and end times for each release.
- Participants need to hold sufficient credits to meet their discharge needs. Credit trading is done via the online credit exchange facility.

- The trading system is online, allowing licence holders to trade quickly and simply. The trades can be for one or many blocks (i.e. a single day or longer periods), and the terms of the trade are negotiated by the parties involved (DEC-NSW, 2006).

10.2.3: Outcomes

An environmental target is attained as shown in Figure 10.7 and salt concentration fell in and after 2002 when the enterprise was perpetuated. Moreover, from Figure 10.7 there are clear signs that change of salt concentration is also controlled. If the result of the auction in 2012 is united and considered (although the detailed data about dealings of a credit cannot be used economically), the resource re-distribution between credit holders is functioning in both the long run and short run, and the economic effect also exists to some extent. The funds required for business continuation can be gained; therefore this enterprise could be evaluated as successful also environmentally and economically (refer to 10.2.4 about auctions).

However, there is also a problem. Initial expenses – for investigation of causal relationships, construction of monitoring systems for measuring salt concentration, development of software, construction of a dealing facility and explanation to participants – are large. However, once a system is started,

subsequent application and improvement expenses will be able to be held down comparatively cheaply. The NSW government is evaluating as follows.

Licence holders' need to discharge depends on highly variable operation conditions at each site. Credit trading gives each licence holder the flexibility to increase or decrease their allowable discharge from time to time while limiting the combined amount of salt discharged across the valley (<http://www.environment.nsw.gov.au/licensing/hrsts/index.htm>, accessed 10 October 2012).

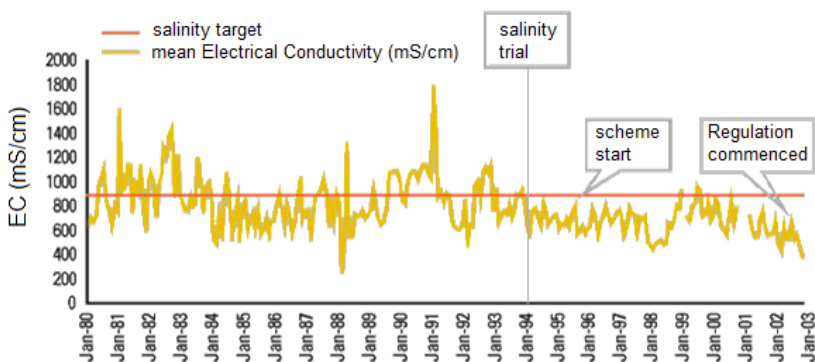


Figure 10.7: electrical conductivity at Singleton 1980 to 2002, monthly means

(Note: salinity is measured by determining the electrical conductivity (EC) of water, which is measured in microSiemens per centimetre ($\mu\text{S}/\text{cm}$). EC estimates the amount of total dissolved salts (TDS) in the water. Drinking quality water usually has an EC of between 600 and 1200 $\mu\text{S}/\text{cm}$ (Source: <http://www.environment.nsw.gov.au/licensing/hrsts/index.htm>, accessed 10 October 2012. Copyright © Office of Environment and Heritage NSW)

10.2.4: Other points of argument

The auction of 200 credits took place as planned on 4 May 2012. The 13 bidders were all companies and there were no new entrants. The credit was distributed to ten companies. The average price of a credit is A\$5737 and HRSTS raised the net return of A\$1,147,444 from this auction. This profit is if it is used for activity of HRSTS (NSW-EPA, 2012, Auction Report, <http://www.epa.nsw.gov.au>. accessed 3 October 2012).

Section 3: MDB Salinity Register scheme

10.3.1: Target and governance

The measure of the credit and register in the MD Basin began from the Salinity and Drainage Strategy (S&DS) of 1989. This S&DS included the operation of joint salt interception schemes, operating a Register of Morgan Salinity Credits and Debits for reporting and accountability. And the Basin Salinity Management Strategy (BSMS) succeeded in this and completed the present integrative anti-salinity program (including salinity register) in 2001 (MDBC, 2003b, p.11).

The target of the BSMS is to attain salt concentration of 800 EC or less by a frequency of 95 per cent or more per year at

Morgan in South Australia by using data observed from 1 May 1975 to 30 April 2000 as the baseline. To achieve this, it also set up a salt target in main branches or at the end of valleys in each state, and attained it. The level of 800 EC in Morgan is based on the WHO standard of drinking water.

Since the quantity of salt that could be discharged is less than the desired value at Morgan, the maximum of an emissions volume is theoretically understood to be the difference of the salt concentration of the present River Murray, and the target of 800 EC.

However, taking into consideration delayed impacts before 1989 and future risk, the amount of discharge is converted into EC of a standard point and, under the circumstances, is set to zero or more. Put another way, a condition is attached so that plus and minus credits of both Register A and Register B may become zero or more. Therefore, when a certain state reduces a credit, a duty of the action that increased a credit is imposed upon the state.

Acts that led to changes in credit are called **accountable actions**. A credit may be called salt disposal entitlement (SDE). A certain act is connected with what credit of increase and decrease, or is calculated by the original model based on the size of the credit of accountable action. Moreover, the salt concentration of the River Murray undergoes monitoring and

compatibility between the model and reality is achieved by the correction of the model based on scientific monitoring and scheduled inspection.⁴

The special feature of BSMS is the creation of engineering solutions (e.g. salt interception schemes) and non-engineering solutions (e.g. land and water management plans) as measures for achieving salinity balance. The structure that unifies these is the salinity register.

The control mechanism in connection with the MDB salinity register is shown in Figure 10.8.

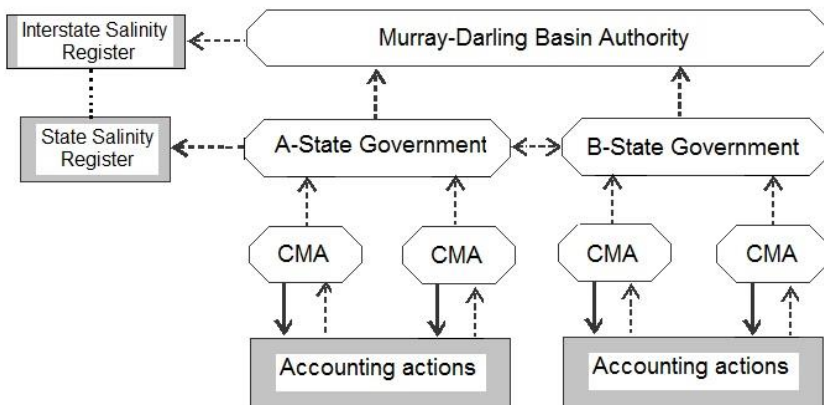


Figure 10.8: structure of MDB Salinity Register Scheme 2012

(Source: created by author.)

Note: the dashed line shows the flow of the information concerning a salt credit and the solid line shows accounting action. Dealings of the credit within state and between valleys are not conducted until the present)

Next, accounting actions are as follows:

- Salt interception schemes reduce the flow of highly saline groundwater to the River Murray, diverting the water to disposal basins away from the river.
- Environmental watering reduces the outflows of salt to rivers.
- New irrigation development can result in increased salt loads in the River Murray. This results in a salinity debit for the destination state of the water trade on the salinity register.
- Removal of irrigation water from highly saline areas can reduce the River Murray salinity impact from those areas. This results in a salinity credit for the state of origin of the water trade on the salinity register.
- Interstate transfer of water entitlements has the potential to affect salinity levels in the River Murray. It can change the volume of water and affects the river's dilution capacity and so changes the salinity level of the water. Under the current arrangements:
 - salinity debits or credits resulting from the dilution effects brought about by the transfer of entitlements to

⁴ NSW, Queensland and SA set up the target [including end-of-valley salinity targets] concerning salinity in 2004, and Victoria set up the target in 2005.

or from SA will be assigned to the upstream state involved in the transfer, i.e: NSW or Victoria;

- salinity debits and credits resulting from the dilution effects brought about by transfers of entitlements between NSW and Victoria will be shared equally by the two states.
- Drainage schemes can result in increased salt loads in the River Murray
(http://www2.mdbc.gov.au/_data/page/114/MDB3614_Fact_Sheet_6.pdf, accessed 3 October 2012).

Next, the activity of the CMA of each state contributes to acquisition of credit for each state. The CMA defines the salinity management plan, undertakes a salinity relief enterprise, and also acquires the salinity credit (PC, 2006, p.220; refer to the example of salt flushing in Lake Charm, A-4, 10.1.2.A).

10.3.2 Mechanisms and management

The mechanism of C&T in the MD Basin is as follows.

Various acts of development, relief acts and salt exclusion acts (i.e. accountable actions) are evaluated using a model. The valuation basis sets a standard point (in the case of the whole basin, Morgan serves as this) to a base year, and measures the ECs of a standard point in the long-term amount of

accumulation before a base year (i.e. 1989). The participants in the basin program take responsibility for acting to ensure that the EC of a standard point attains a desired value. For this reason, when the EC of a standard point goes up due to acts of development, it is necessary to undertake enterprises that reduce the equivalent EC so that it can be offset to purchase others' credit, or to invest jointly in others' EC reduction enterprises.

The MDBC/A has two registers, A and B. B Register records the delayed impacts before 1 January 1988 and accumulates the impacts after that.⁵

On the other hand, the actions that contributed to the reduction in salt concentration within one year, and the size of the reduction, are quantified and A Register records this (i.e. salt disposal entitlement increases). When X state wants to increase a credit, the salt relief enterprise Y state undertakes is financed 50 per cent, and if the enterprise concerned is an enterprise with the reduction effect of 1 EC, X state can gain the credit of 0.5 EC. This action is called 'joint works and measures' in Register A.

⁵ When raising the average EC concentration of Morgan 0.1 degree within 30 years from now on, negative credits, i.e., a debit, increase 0.1 credits.

Each state manages salt discharge as follows.

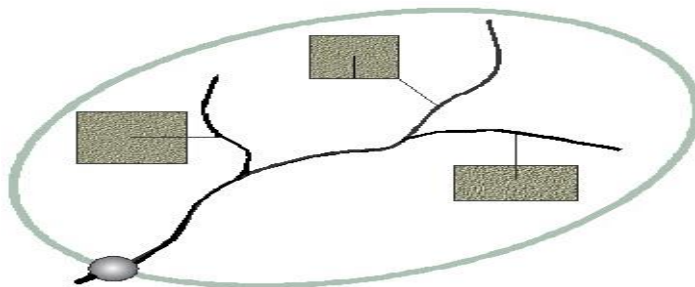


Figure 10.9: end-of-valley target at valley level

(Source: created by author)

When CMAs and water utilities set an **end-of-valley target** as shown in Figure 10.9, and they look at the increase and decrease, the required offset enterprise is undertaken.

This target is called end-of-valley salinity and salt load target.

Furthermore, a state government sets a desired value to a point (B, C, D, E) that unifies some valleys (refer to Figure 10.10).

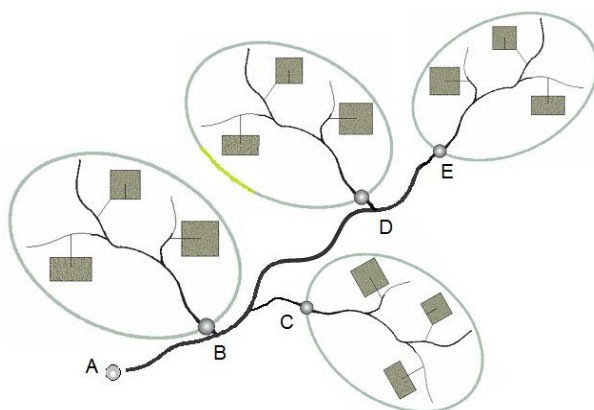


Figure 10.10: end-of-valley targets at state level and basin level

(Source: created by author)

Furthermore, MDBA sets the target of the whole basin as A. This is called the basin target and is a desired value in Morgan, SA. Each state government is responsible for achieving the end-of-valley targets within the state, and the MDBA has responsibility for achieving the whole basin target. Moreover, each CMA has responsibility for achieving the management target of each valley. In this way, the salt concentration of the whole basin is managed.

10.3.3: Outcomes

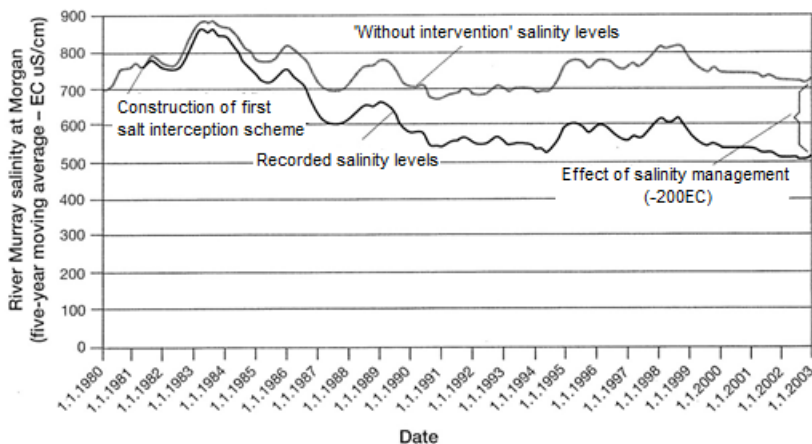
In the long run, in 1985 and afterwards, the environmental target was attained and deviation with a desired value and an observed value is expanded as shown in Figure 10.11. Therefore, it can be estimated that it has succeeded environmentally.

Economically, credit dealing is not performed in a monetary meaning. Therefore, there is not necessarily a market that conducts credits trading, and the credits are not necessarily dealt in.

However, credits trading is conducted in the following two meanings. First, it comes out through the expense burden of the offset enterprise by joint work. The second comes out through the interstate water entitlements trading. For example, when an

upstream state exports water entitlements downstream and increases credit because of dilution, such benefits as the right to development can be produced in an upstream state as a result and water resources are redistributed to the Pareto optimum state where the upper stream, the lower stream, and the environment have a merit. That is, in this case we can understand credits trading as a modification of water entitlements trading.

Looked at this way, the scheme of the MDB Salinity Register Scheme (MDBSRS) can be considered to be an application of market-based instruments.



**Figure 10.11: Long-term average salinity levels,
River Murray, Morgan, SA since 1980**

(Note: the figure compares the change in EC in Morgan at the time of not performing accounting action with change of an actual observed value. In these 20 years, it turns out that EC could be controlled by about 200 and it is less than the target of 800 EC

Source: Pigram, p.168, originally from Kendall 2003)

The merits and negatives of the MDB Salinity Register Scheme (MDBSRS) are summarised as follows.

- Negatives of the MDBSRS:

1. After setting up, it is left to a participant to make further decisions, but the setup expense for starting a market and structure is high.

2. Although the relation between causal acts and discharge can be modelled in a big area, it is difficult under the present circumstances to subdivide a model even into each farm and irrigated district level and to specify causal relationships.

Therefore, the reality is that salt credits trading are limited to the state level at present.⁶

- Merits of the MDBSRS:

1. It brought pliability to management of salinity. As all activities (i.e. accountable actions) including water trading are convertible into a common currency called a **salinity unit**, development is not restricted too much and, specifically, an enterprise, irrigation development work, etc. of engineering can secure fixed pliability.

⁶ In the Coleambally Net Recharge Scheme, dealings on the level of individual irrigation farmland were tried experimentally. Refer to C-2, 10.1.2.C. In the MDB, market trading about the salinity between catchment levels is not developed.

2. It becomes a merit to reduce salt concentration (i.e. a credit increases). The increase in credits enables new development and investment to occur. That is, this scheme can give a participant an incentive to reduce salt.

3. Business funds undertaking joint enterprises to reduce salt can gain to some extent.

4. Compared with engineering enterprises, such as a salinity interception enterprise, the reduction cost is cheap.⁷

10.3.4: Other points of argument

(1) The design method of C&T

The PC report said that in order to operate C&T well, it should be carefully designed to the following points.

⁷ A trading market for salt would also provide price signals to identify which abatement activities are the cheapest methods, among both the on-farm and engineered interception approaches. [PC, 2006, p.241].

1	To understand causes, and their biophysical processes and the relationship of contamination
2	To build a model can reproduce the process by which a contaminant is discharged on the level of a farm, an irrigation division, a drainage basin, etc., and accumulate it all
3	To grasp the number of heterogeneous participants involved
4	To grasp the number of participants who receive benefits when a market is built in the fixed area
5	To decide whether to be a system that can respond to new situations, technical innovation and scientific discovery etc., that can reduce the contamination
6	To attain the removal of unnecessary regulation and reduction of the transaction costs
7	To develop a support system so that integration, separation, etc. of emissions rights becomes easy
8	The whole enterprise is monitored and a statute standard is observed.

Table 10.2: how to design the C&T by PC

(Source: created from PC, 2006, p.238)

In order to operate over a large area and for a long period, and since the trade-off between targets exists, control of measures against salinity is difficult and, generally, a market-based instrument alone may not be sufficient. Measures must be taken that include regulation techniques (regulation and planning) or engineering options and various policies must be combined and cooperate with other means of control. Moreover, in order to allow for uncertainties, the technique of adaptive management is needed.

The market-based instrument (i.e. cap and trade) is effective when there is still a margin in reaching an environmental threshold, and it is adapted for slow change. When a result covering a comparatively long period of time (for example, for five to ten years) is required, PC analyses it as probably having validity.⁸

(2) Development of a salinity measurement model

The necessity for salinity measurement model development is as follows:

- When there is a time lag between the cause of salinity and its revelation, analysis of a model is needed to understand the result. Moreover, the model can predict future influences and the means to prevent bad influences can be provided.
- In the present condition of model development, although the relationship between cause and effect cannot be specified at an individual, the influence on the overall area as a whole can be visualised. Furthermore, transparency and objectivity can be provided to help understand of a

⁸ Where the effects are gradual and not likely to reach a threshold, market mechanisms that involve slower market and environmental responses may be a more cost-effective option (PC, 2006, p.235).

policy means and an effect, and fundamental measures can be considered.

A famous model of salinity measurement in the MD Basin is called SIMRAT.

The Murray-Darling Commission and CSIRO, in conjunction with private industry, have developed a model called the Salinity Impact Rapid Assessment Tool (SIMRAT) to simulate salinity effects from changing irrigation land use. SIMRAT can be used to estimate the salinity effects of:

- Water trade
- Changes in water-use efficiency
- Changes in land use on infiltration rates (such as revegetation)
- Environmental watering (PC, 2006, pp.232–3).

It is that model that predicts damage of groundwater from salt water and the relation of farm drainage. SWAGMAN (Salt Water and Groundwater Management model) was developed for groundwater and used for emission trading of groundwater (PC, 2006, p.234).

It seems that the MDBC (the forerunner of the MDBA) is also developing a model called the River Murray model.

In March 2003, the commission approved the River Murray Model (MSM-Bigmod) as an appropriate model to stimulate the salinity, salt load and flow regime, each on a daily basis in the Upper River Murray and the River Murray in South Australia (MDBC, 2001b, p.13).

Section 4: Summary and conclusions

This chapter examined the example of salinity emission rights trading in order to consider relations of a water market and environmental preservation.

Salinity credits trading can be considered to be the C&T application to water quality control. This chapter examined focusing on salinity credits trading of the Hunter River, and the salinity register scheme of the MD Basin. Although the former has few participants and is dealing with a comparatively closed space, its main feature is that it quickly determines the daily amount of discharge and enables credit trading.

On the other hand, by building a multi-storey managerial system and a system that converts heterogeneous activity into a common currency called a salinity unit, the latter turns various activities to an environmental target, and unifies them. This can be said to be a very skillful method of managing long time and vast space exceeding a judicial difference. As this scheme does

deal directly with money, it cannot be said to be emission rights trading, but because it is indirectly accompanied by payment, it can be said to be a variety of emission rights trading.

Both can predict considerable environmental success is attained, and claim that so far the expected economic effect has been attained.

Salinity credits trading do not in themselves have a bad influence on the environment because the salt total does not change. Moreover, when salinity credits trading are connected with water entitlements trading, it can be improved by using the water allocation when salinity gets worse. Even if salinity further worsens, it has succeeded by having other environment management systems, such as CMA, stop this fundamentally through accounting actions. Salinity credits trading are therefore estimated on the whole to have an affirmative rather than a negative influence on the environment, when the means compensated with the influence of minus, such as CMA, exists.

The following points have become clear in analysing the credits (or emission rights) trading of Australia:

1. Emission rights trading is not effective at an individual level when it is difficult to clearly grasp a causal relationship between an individual's action and the influence on the

environment. Moreover, in order to respond to a rapidly changing situation, a small individual management level is not enough for the participants in dealings.

2. A large amount of initial investment and annual administrative and maintenance expenses is required for emission rights trading and, in order to support this, participation is difficult for an individual small-scale manager. That is, as for salinity emission rights trading, it is more realistic to conceive them as dealings between big managers (for example, a company and a state government).

3. The experience of the Hunter River proved that emission rights trading is actually possible and manageable by setting the daily maximum amount of discharge to a river. And it proved it can achieve a desirable result environmentally and economically. That is, it showed clearly that emission rights trading is effective for salinity management.

4. It showed that the experience of the MDBA made various heterogeneous activities balance by producing a common measure, and could use a salinity register for environment management over a wide area and a long-term apart from any judicial difference.

5. It is desirable for there to be two or more management tools (such as CMAs and water corporations) for sustainable water resources management.

6. It is desirable and realistic not only environmentally but also economically to use salinity emission rights trading as a measure against salinity. Salinity emission rights trading and the environment can achieve a symbiotic relationship as compensation for any negative influences.

Chapter 11

Environmental Flow and Water Market

This chapter considers the relationship between a water market and environment management focusing on e-flow (environmental flow). Section 1 considers an e-flow. Section 2 considers how to secure water for the environment. Section 3 examines the case of The Living Murray Initiative (TLM), and Section 4 examines the case of the Rivers Environmental Restoration Program (RERP) of NSW. Section 5 considers an example from other e-flows. Section 6 considers the meaning of an e-flow theoretically as related to the Coase theorem. Section 7 is summary and conclusions.

Section 1: What is e-flow?

Environmental flow (e-flow) is called environmental water, water for the environment or water for ecosystems. The meaning is as follows for the time being.

Environmental water is the water provided to wetlands, floodplains or rivers to achieve a desired outcome, including benefits to the ecosystem, biodiversity, and water quality and water resource health (<http://www.mdba.gov.au/draft-basin-plan/draft-basin-plan-chapter-summary/glossary>, accessed 12 October 2012).

It is obvious that water is required for healthy maintenance of the environment. Therefore, the following problem concerns the relationship between e-flow and environmental soundness, and takes priority (Section 2 examines the priority problem).

The first problem, to grasp of a relationship of e-flow to environmental soundness, is considered as follows:

- In rivers that have been dammed, or are being used for irrigation, the normal flow is changed. In other situations, where water is added to a river, such as outflow from a sewage treatment plant, the natural flow of the river is also altered. Environmental flows are designed to mimic the natural condition of rivers. It is not solely about the amount of water but also timing and quality.
- It is important that environmental flows mimic in the variability of flows. The quality of water released below dams can sometimes be compromised by lower than

normal water temperatures, low dissolved oxygen levels, or other water quality parameters. Releasing water of substandard quality can severely impair the functioning of aquatic ecosystems.

- The purpose of environmental flows is to protect the aquatic ecosystems. By identifying particular elements of the aquatic ecosystem we want to protect (ecological objectives) we can then target these with particular environmental flows.

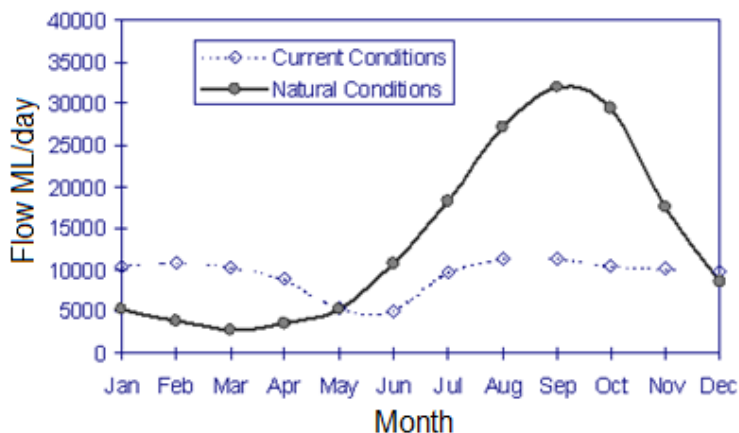
(http://www.environment.act.gov.au/_data/assets/pdf_file/0006/152925/Environmental_flows_fact.pdf, accessed 12 October 2012).

As the natural flow was spoiled by construction of a dam or weir, thus causing degradation of river's ecosystem, e-flow means that water will be secured for the environment and the recovery of the environment will be sought.

The present river actually serves as a natural flow with what was widely different.

Although the Figure 11.1 compares the natural flow in Yarrawonga Weir of the lower stream of the River Murray with the actual flow, a natural flow shows large changes as there are few flows in summer-autumn (Feb-Apr) and many in winter-

spring (Aug-Oct). On the other hand, the actual flow is reversed (refer to Figure 11.1).



**Figure 11.1: median monthly flows River Murray
downstream of Yarrawonga Weir**

(Source:

http://www2.mdbc.gov.au/nrm/water_issues/environmental_flows.html, accessed 4 October 2012, partly modified)

The flow regime notionally clarifies the natural state that it should be restored to (refer to Figure 11.2).

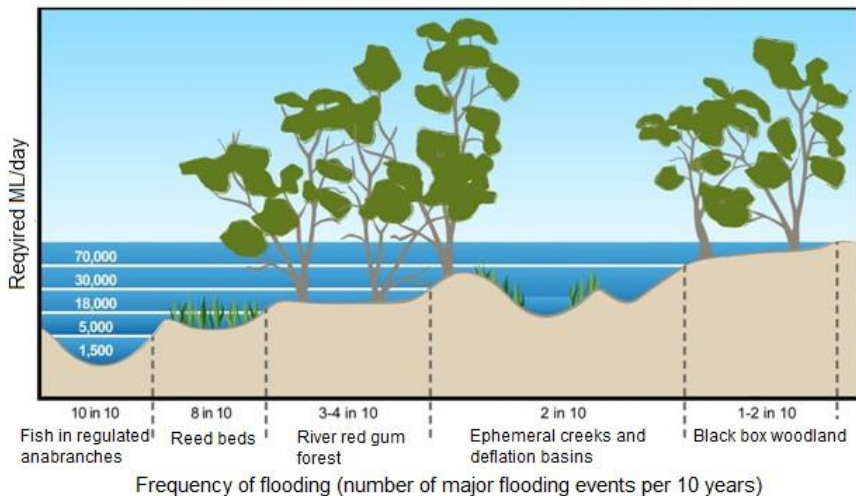


Figure 11.2: conceptual illustration of flow regime

(Source: <http://www.mdba.gov.au/draft-basin-plan/supporting-documents/mdba-eslt/ch05>, accessed 4 October 2012, partly modified)

The long term characteristics and variability of these flow events is called a **flow regime**. The flow regime of rivers is often categorised into a number of discrete components as shown in Table 11.1 and Figure 11.2 (<http://www.mdba.gov.au/draft-basin-plan/supporting-documents/mdba-eslt/ch05>, accessed 5 October 2012).

Cease to flow periods (or extreme low flows)	During a period of natural extreme low flows, native species are likely to out-compete exotic species that have not adapted to those very low flows.
Baseflows (or low flows)	Low flows maintain adequate habitat, temperature, dissolved oxygen, and chemistry for aquatic organisms; drinking water for terrestrial animals; and soil moisture for plants. Stable low flows support feeding and spawning activities of fish, offering both recreational and ecological benefits.
Freshes (or high flow)	High flows generally lead to decreased water temperature and increased dissolved oxygen. These events also prevent vegetation from invading river channels and can wash out plants, delivering large amounts of sediments and organic matter downstream in the process. High flows also move and scour gravels for native and recreational fish spawning and suppress non-native fish populations, algae, and beaver dams.
Bankfull flows (or small floods)	Small floods enable migration to flood plains, wetlands, and other habitats that act as breeding grounds and provide resources to many species. Small floods also aid the reproduction process of native riparian plants and can decrease the density of non-native species.
Overbank flows (or large floods)	Large floods can change the path of the river, from new habitat, and move large amounts of sediment and plant matter. Large floods also disperse plant seeds and provide seedlings with prolonged access to soil moisture.

Table 11.1: five components of flow regime

(Source: created from web pages of MDBA and Victorian Government and Wikipedia- Environmental flow, accessed 5 October 2012.

Note: ‘Freshes’ and ‘high flows’ are distinguished in Victoria)

As mentioned above, an environmental flow restores the flow pattern of an artificially changed river to a natural flow pattern and maintains environmental soundness.

Measures for the environmental flow problem in Australia moved forward greatly in 1995 by taking advantage of the introduction of Cap (refer to Section 2 of Chapter 9 for the background of Cap, environmental water entitlements and water resource plans). Discharge from the dam for reproducing a natural flow was performed in 1998, the Barmah-Millewa Forests Water Management Strategy was created in 2000, and a track record for environmental flow began to be accumulated. These actions led to the adoption of the TLM scheme in 2002 (refer to 1.2.7 for TLM and Section 3 of this chapter). In addition, with the Water Act (Cwlth) being approved in 2007 along with simultaneous legal recognition of environmental water entitlements, the CEWH (see 9.2.6) was installed as a mechanism for managing it. Similarly, Rivers Environmental Restoration Programs (RERP) were carried out by NSW in 2007, and environmental regeneration occurred (refer to Table 11.2).

	Australia	World
1990s	1994 An audit of water use in the MDB was conducted to assess the long-term sustainability of ever-	1992 Dublin Statement on Water and Sustainable Development was

	<p>increasing development and water diversion.</p> <p>1995 Cap was introduced in MDB in response to findings of the Audit (MDBC).</p> <p>1996 Interstate Working Group on River Murray Flows was formed to develop a flow management plan for the River Murray (MDBC).</p> <p>1998 Environmental Flows Project Board was formed (MDBC).</p> <p>1998 The 100 GL of water in the Hume Dam was released firstly to supplement a minor flood already occurring in the Barmah-Millewa Forest (MDBC).</p> <p>1999 Hume and Dartmouth Dams Operations Review was released (MDBC).</p>	<p>declared.</p> <p>1992 Removal of dams started in US. ('Elwha River Ecosystem and Fisheries Restoration Act of 1992' was enacted.)</p> <p>1998 World Commission on Dams was set up.</p>
2000s	<p>2000 Report of the River Murray Scientific Panel on Environmental Flows was released (MDBC).</p> <p>2000 The Barmah-Millewa Forests Water Management Strategy was released (MDBC).</p> <p>2000 River Murray Barragers Environmental Flows was released (MDBC).</p> <p>2002 The Living Murray Initiative (TLM) started.</p> <p>2002 Victorian River Health</p>	<p>2005 U.S. Army Corps of Engineers (USACE) has changed its operation of Alamo Dam to incorporate more natural low flows and controlled flood.</p> <p>2007 The Brisbane Declaration on Environmental Flows was endorsed by more than</p>

	<p>Strategy was released (Vic).</p> <p>2003 The Commonwealth, together with the governments of NSW, Vic, SA and ACT, agreed to a ‘First Step’ decision.</p> <p>2004 The intergovernmental agreement* signed and set financial and volumetric targets for TLM.</p> <p>2005 NWS Riverbank was initiated.</p> <p>2006 Commonwealth supplementary contributed to TLM (2006–11).</p> <p>2007 Rivers Environmental Restoration Programs (RERP) was established (NSW).</p> <p>2008 MDBA and CWEH started.</p>	<p>750 practitioners from more than 50 countries.</p> <p>By 2010, many countries throughout the world had adopted environmental flow policies.</p>
2010s	<p>2010 Basin Plan including e-flow was released (MDBA).</p> <p>2011 VEWH was established (Vic).</p>	

**Table 11.2: history of tackling environmental
flow in Australia and the world**

**(Note: *the official name is the Intergovernmental Agreement on
Addressing Water Over-allocation and Achieving Environmental
Objectives in the Murray Darling Basin.**

**Source: created from web pages of MDBC, MDBA, Victorian
Government and Wikipedia, accessed 4 October 2012)**

Section 2: How is the e-flow secured?

11.2.1: The problem involving the priority of the e-flow

As described in 6.2.4 of Chapter 6, water resource plans deal with the allocation of overall water resources, including water for the environment. Therefore, although water for the environment and water for consumptive use are formally treated equally legally, securing water reservation for the environment is the priority after satisfying the water needs of cities and irrigators. This is because it is difficult to objectively determine how much water to secure for the environment. And for regulated rivers, only the minimum water for the environment (base flows) is secured.

However, demands for this priority to change are coming from two directions. First, by repeating various experiments on environmental flow and the relationship between environmental maintenance and reproduction, the required amount of water and usage is scientifically clarified and the facts are affecting various water resources distribution plans. Examples are Living Murray First Step and the Basin Plan.

The second is a move to purchase environmental water entitlements through a water market. Water for the environment

has been secured from a water market using government funds and private funds. The activity of CEWH is an example.

These activities have been changing the allocation of water resources. Therefore, the present condition is that acquisition of an environmental flow changes the distribution ratio of water resources, and this trend is changing the environment's priority in the allocation of water resources.

Next, reservation of water for the environment in a water resources plan is explained.

The central purpose of the present plan is to secure base flows of a river. The model reproduced and considered a natural flow for that purpose and decided upon the amount of water required.

Hydrological modelling and environmental impact studies are used to identify environmental requirements, with the principal objective being to mimic the natural flow pattern of the watercourse (PC, 2006, p.164).

Legal power is granted to the government as a means for achieving this plan. Specifically, the government can lawfully secure water for the environment by the following three means:

(#1) command based on a statute

(#2) secure water for the environment and give to the environment

(#3) take from the existing water rights.

There is a legal requirement that a water supplier (e.g. a water corporation) and the river administrator have to do their best to acquire a base (or minimum) flow. This is (#1).

Distributors or the river manager are required to ensure that environmental requirements are satisfied, using the powers given to them to restrict the volume and timing of water extractions by rights holders (PC, 2006, p.164).

In fact, water corporations supply and manage this base (or minimum) flow (refer to Note 1 of Figure 9.2 of Chapter 9).

Next (for #2), NSW, Victoria and SA have a legal right to deal in environmental water rights (entitlements) (refer to 9.2.2). In order to satisfy this necessity, water entitlements are purchased from the water market.

In respect of #3, the power to restrict water entitlements to the government is determined by law.

In some jurisdictions, governments can obtain additional water for environmental purposes by reducing the volume of water attached to existing water entitlements. This changes water

entitlements to return the level of extractions to sustainable levels so that environmental objectives can be met (PC, 2006, p.164).

It seems, however, that there is no example of this actually happening. The method of (#2) is used chiefly.

11.2.2: Means to secure the e-flow

The means of securing the e-flow is roughly divided into two methods.

One is a method by infrastructure construction, and the way another uses market-based instruments.

Reservation of e-flow by infrastructure construction is as follows.

- infrastructure-based projects: an open irrigation waterway is pipelined and the loss by transpiration is prevented. Loss can be further prevented by shortening an extended distance of waterway, or by preventing the leakage from the connection. Further loss can be prevented by improving the water supply time by installing a measuring device or similar.
- on-firm projects: changes in water-conservation-type irrigation technology, development and conversion of low-water-use crops, recycling of agricultural runoff.

Furthermore, with water for cities, projects that achieve water saving by increased efficiency and recycling for water supplies, and projects such as desalinisation (that changes sea water into fresh water) are also undertaken (urban projects).

Market-based instruments include purchasing water rights by bid from sellers (tender), and purchasing from a water market (market-based measures). There are also the following methods:

- **Leaseback:** lend the purchased water entitlements for the environment. A buyer purchases water entitlements instead of the government, and lends them to an irrigation farmer (**environmental leaseback**). There are also ways of lending the fixed water entitlements an irrigation farm owns to the purchaser of the environmental purpose (**irrigator leaseback**).
- **Covenants:** how to purchase water rights and add conditions or a contract to this right after that. The new right to have various access conditions can be made. However, it is complicated (MDBC, 2006c, Issues and options in applying market based measures in the Living Murray First Step, online, accessed 8 August 2008).
- **Forward contracts:** in some cases, environmental managers may need to source additional water before the

start of the irrigation season. This is the method of securing water at a time when the water market is not established. Before an irrigation season starts, water is accumulated in some storage. Forward contract is the method of purchasing the water of this storage by a contract for when the stored water can use using a certain water supply service (PC, 2006, p.192).

- **Option contracts:** premised on the developed water market, if it becomes more than the price a buyer expects, it will sell off using an option right. (This is called a put option. It is bought and, in the case of a call option, if it falls below the expected price, it will be purchased using an option right). On the other hand, an option right is not used if the expected price is not reached.

Example: [In the case of call option]: an environmental manager pays the irrigator an option premium for the right, but not the obligation, to buy a quantity of water at a determined price when allocations are above a certain threshold (for example 70 per cent of allocation) at specified periods during the year. The irrigator retains the permanent entitlement and, in addition to the option premium, receives further pre-specified payment (the option exercise price) when the environmental

manager exercises the option to buy water. More detailed analysis of the PC report on option contracts follows:

- Environmental managers and service providers could take advantage of counter-cyclical demand by negotiating to purchase water only in wetter years when it is generally less valued by irrigators, rather than purchasing entitlements that would provide excess supply in most years.
- Option contracts could reduce transaction costs associated with selling seasonal allocations in average and drier years, avoid ongoing infrastructure charges associated with holding entitlements, and ensure that enough water can be sourced at short notice to augment high flow events.
- Murrumbidgee Irrigation and the Murrumbidgee Catchment Management Authority have proposed an options exchange for Murrumbidgee Valley (PC, 2006, p198-9, originally from Hafi *et al.*, 2005).

However, the actual options market is yet to be established (refer to Schreider, 2009, pp.364-5).

The conditions of the tender bid in the case of TLM were as follows.

Those who fulfill the following two conditions by a water rights holder purchase water rights on a government competition target.

- (1) The productivity of a farm is not spoiled even if it loses water.
- (2) Those who can make a definite promise to do their best to increase water efficiency of in line with the 'water efficiency measures'.

A farm wanting to sell water entitlements was asked to notify a suggested price until December, 2006, and eventually the government can choose the tenders which achieve the greatest environmental effect within the limits of budget constraint (PC, 2006, p.175).

PC has stated the merits of using a water market including the e-flow to allocate water resources as follows:

Market mechanism not only provides for mutually beneficial exchanges between environmental and non-environmental water users, [but] they can also make allocative decisions more transparent by revealing the value of water in other uses (PC, 2006, p.167).

Section 3: The Living Murray Initiative (TLM)

At present, The Living Murray Initiative (TLM) is the greatest enterprise in Australia attempting environmental rehabilitation by reserving water for the environment. Agreement was made among the governments in 2002 and the enterprise (referred to as First Step) started in 2004. The greatest target was securing 500gl of water for the environment by the end of 2009 for six icon sites. Although this enterprise was challenging, it fundamentally succeeded and had a big influence on the subsequent establishment of the CEWH and the Basin Plan. Now, reservation of water for the environment and restoration of the flow regime serve as a big pillar of Australia's water environment policy.

11.3.1: Targets and governance

The purpose is to reproduce the natural flow of the River Murray and to restore the ecosystems (for fish, animals, plants, water birds, invertebrates) of the river. Because it is unrealistic to restore all environments, the key environmental assets are selected depending on context or urgency. These are called **hydrologic indicator sites**. The amount of water required to restore these environmental assets to a desirable state, threshold/volume, duration, frequency and timing are calculated

by considering these sites as environmental representations. Computer software (for example, the Victorian FLOWS method is famous) that incorporates environmental flow assessment techniques developed so far is used to calculate the amount of water required for each site.

In TLM, the following six icon sites were appointed:

- Barmah-Millewa Forest
- Gunbower Koondrock-Perricoota Forests
- Hattah Lakes
- Chowilla floodplain and Lindsay-Wallpolla Islands
- Murry Mouth, Coorong and Lower Lakes
- River Murray Channel

and the amount of water required for environmental regeneration was calculated. The result is a basis of 500gl.

To provide administrative support for these plans, an intergovernmental agreement (the Intergovernmental Agreement on Addressing Water Overallocation and Achieving Environmental Objectives in the Murray-Darling Basin) was concluded between NSW, Victoria, SA, the ACT and the federal government in June 2004.

Although the state governments were to provide A\$500 million and the original contribution of the federal government

was A\$200 million, the federal government injected additional funds in 2006 and it became a A\$1 billion enterprise in total.

Enterprise execution organisation was as follows:

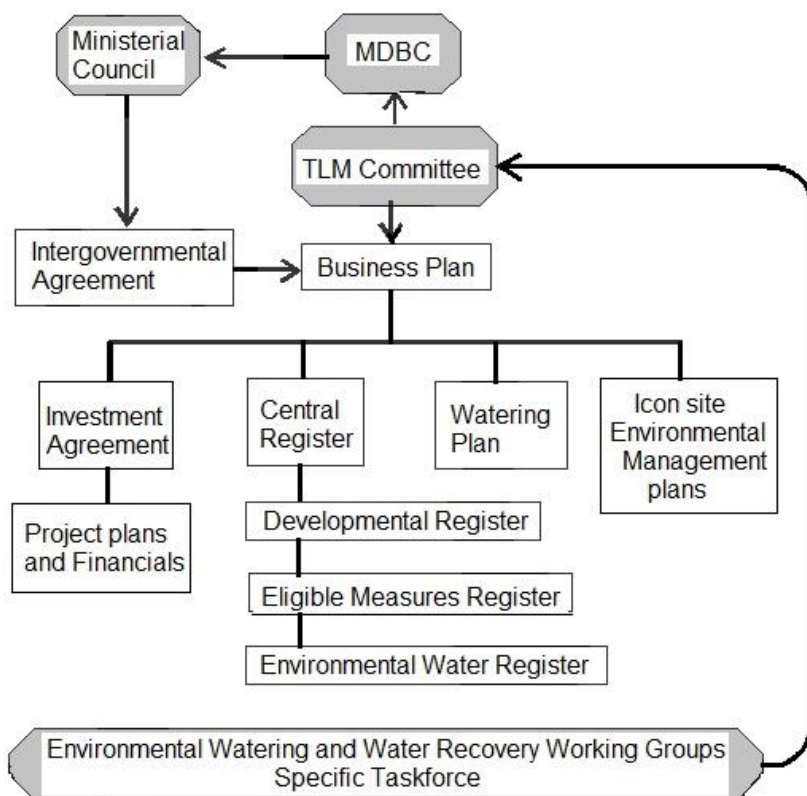


Figure 11.3: architecture of TLM

(Source: MDBA, 2009, Progress Report, p.12, partly modified.

Note: the intergovernmental agreement sets financial and volumetric targets for TLM and the business plan provides operational guidelines for its implementation. The environmental watering plan is aimed at guiding the use of recovered water to achieve TLM's agreed environmental objectives. Central register has three sub-registers. The amount of water which can actually be used as an environmental flow is the amount of water entered into the environmental water register)

The progress report analysed the execution problems of this organisation as follows:

Administrative and governance arrangements for TLM have been highly complex. Over the life of TLM, decision making has typically involved a hierarchy of committees, working groups and taskforces The decision-making process did not appear to be nimble enough to respond to a rapidly changing environment. This meant it was difficult to change direction or refocus commitments under TLM in the wider context of the increasing risks to water resource availability in the Murray Darling Basin. The lack of a single decision-making authority meant accountabilities were often unclear and not transparent (MDBA, 2009, p.23) .

Next, the organisation that monitors the environment of the MD Basin has been built continuously. The MDBC is completing the framework of the river ecosystem by systematic evaluation and standardising based on the pilot survey, in cooperation with various governmental agencies in 2004 in order to evaluate the soundness of the MD Basin rivers. Although this framework is called the Sustainable Rivers Audit, it is an investigation carried out at the MD Basin into the health conditions of the maximum scale of the rivers and is the first systematic investigation about

the soundness of a river. The Sustainable Rivers Audit is undertaken in a six-year cycle by an independent researcher and organisation. Fish, crustaceans, hydraulics, aquatic plants, geographical features and the state of flood plains are the main features being observed.

11.3.2: Management in relation to MBIs

The problem of water reservation for the environment by infrastructure construction became clear in advance of TLM.

Although the Living Murray enterprise has so far concentrated on infrastructure investments, such as lining channels, installing pipelines and installing metering systems, the constraints of A\$1000 per 1ml were not attained. Consultant ACIL Tasman predicted that the expense of getting water up to 365gl increases from A\$1000/ml to A\$1500/ml. At 420gl, it went up to A\$4500/ml and when 488gl was exceeded, it was predicted to rise faster. Reservation of water by infrastructure investment is not only expensive, but is problematic in respect of the character of water supply required for environmental management, such as certainty of water supply and dam storage. Water reservation by infrastructure construction requires time and it became clear that it could attain 60 per cent or less of TLM targets (i.e. 500gl by 2009). Furthermore, because groundwater and front running water were connected, even if

pipes were lined, groundwater decreased and the amount of water used as a whole did not increase (PC, 2006, pp.168–71).

For such reasons, the infrastructure construction was gradually transposed to the market-based method.¹

The TLM progress report describes the gained water as follows:

- 200.4gl were recovered through market mechanisms, ranging in cost (A\$m/gl-LTCE) between A\$0.99 million/gl (LTCE) and A\$2.45 million/gl (LTCE).
- 137.28gl were recovered through infrastructure projects ranging in cost from A\$1.02 million/gl (LTCE) to A\$3 million/gl (LTCE).
- 145gl were recovered through a mix of infrastructure and regulatory projects estimated at around A\$0.64 million/gl (LTCE) based on A\$93 million as the total project cost.
- 13gl have been recovered through other mechanisms at a cost of between A\$1.4 million/gl (LTCE) and A\$1.53 million/gl (LTCE) (MDBA, 2009, p.21)²

¹ There was an over-reliance on infrastructure projects to recover water early on in TLM. Market measures were not actively considered until 2006 following recommendations from the Intergovernmental Agreement (MDBA, 2009, p.16).

The water eventually secured with the market technique (the purchase of water entitlements from a water market or an irrigation farmer) was 200.4gl, which was 40 per cent of the target. It is said that the purchase expense is A\$990/ml to A\$2450/ml, and the market technique is cheaper than the infrastructure projects.³

² The LTCE is a unit of measure used to create a common currency for the volumes of water recorded under TLM and registered on the eligible measures register. The LTCE or volume registered for a particular recovery work or measure is calculated using the accepted best practice cap computer simulation models for that system as the:

- long-term average contribution to cap; or
- potential contribution to long-term average flows in the relevant river valley (MDBA, 2009, p.6).

³ The central register [January 2009] shows that overall infrastructure projects have a greater A\$/gl [LTCE] cost than market mechanisms (MDBA, 2009, p.22).

11.3.3: Outcomes

In the TLM progress report released in March 2009, the prospect that 495.68gl would be secured to the 500gl target in December 2009 was given (MDBA, 2009, p.17). Moreover, according to *Plain English summary of the proposed Basin Plan* released in November 2011, the MDBA water calculation described that 1068 gl/y of water for the environment was secured through buyback and infrastructure improvement schemes (also including the water gained by TLM). Therefore, it is possible that the aim was fundamentally achieved. This can especially be said to be a big result if the severe drought of 2004 is taken into consideration.

However, the 2009 progress report also pointed out some problems. As the problem of management has already been described, we will not repeat it here. As for the 500gl of water that was gained by TLM, there is a problem in the degree of reliability. According to the report, about 7 per cent of the water gained by TLM is high-reliability water and the amount of water that can actually be used for the environment in times of drought will decrease extremely. In spring, 7.19gl of water can actually be used in presumption of a case of drought about the same severity as in 2008-09. And, in autumn, it is 95.12gl. Therefore, in order to heighten the operational effect of water for the environment, it is necessary to raise the water's degree of reliability (MDBA, 2009, p.19).

The second problem is examination and construction of the system for using the gained water for the environment in a timely manner. The report describes this as follows:

Owing to the different types of approval currently required under various state and Commonwealth laws for the use of environmental water at a particular site, it is recommended that the MDBA investigate ways to meet the water use approval requirements to use TLM water and ensure that flexibility for use is not reduced into the future. These investigations should extend to water trading processes particularly in regard to the timing required for approvals (MDBA, 2009, p.20) .

The third is development of a river operation strategy, and the succession of the TLM enterprise to the Basin Plan:

There is an urgent need for the MDBA to develop river operation strategies and determine appropriate triggers for environmental watering to ensure that the river operations team is 'event ready'. This will require the cooperation and goodwill of all TLM partners (MDBA, 2009, p.20) develop an instrument or mechanism for TLM that links TLM to the role of the MDBA and the basin plan and formalises TLM as a subprogram in the MDBA (MDBA, 2009, p.26).

However, TLM advocated environmental reproduction and mostly achieved the aim of an environmental flow of 500gl. The success of this TLM enterprise will serve as a new milestone in Australia's water environment policy. From now on, verification of whether predicted results are actually achieved using water for the environment, and knowledge about the necessary quantity of water for the environment or the method of use, will increase. This will lead to an accumulation of new knowledge and technology to enable the coexistence of the environment and economic activity and to the development of the technique and means for better management of the environment. Surely the TLM enterprise set a new direction with such a water environment policy.

Next, we describe some results about the environmental regeneration aspects of TLM. In SA, 4.6gl of water gained as environmental flows was used for the following two enterprises:

- (1) The Chowilla Floodplain, one of the six icon sites of TLM, occupies an area of 17,700ha. Also known as the Ramsar Convention, it is a famous area internationally. It is the only area in the downstream part of the Murray not used for irrigation, but is left to nature. However, the ecosystem of this area has been subject to river control or the influence of the latest drought. 2.6gl of water was poured from January to

May 2008 at five places (Twin Creeks, Werta Wert, Punkah Creek, Monoman Island Horseshore and Lake Littra) in this area.

- (2) Also in the downriver damp area (Morgan's Lagoon, Jury Swamp, Riverglades, Swanport, Paiwalla Wetland) from Lock 1 of the River Murray, 2gl of water was poured by the end of February 2008. If water is not poured, soil is sulfurated and it is surmised that it had an unrecoverable influence on the natural environment and water quality (MDBC, 2007, accessed 8 August, 2008).

Section 4: NSW Rivers Environmental Restoration Program (RERP)

The NSW government and the Australian government contributed jointly from September 2007 to June 2011 and water for the environment was secured by using a variety of MBIs. A trial of environmental reproduction was carried out. Funds used totalled A\$181.12 million and 108gl of water was gained for the environment. (The purchase expense of water is an arithmetic average of A\$1677/ml. This is cheap compared with the A\$2000/ml arithmetic average of TLM). This enterprise achieved various results, such as the simultaneous development of a forecasting model for the amount water for the environment required for reproduction and maintenance of the environment, and environmental change 100 years after.

11.4.1: Target and governance

The target was set up as follows:

... arrest the decline of the most stressed and iconic rivers and wetlands in New South Wales through market-based water recovery focused on the voluntary acquisition and effective, active management of environmental water (DECCW-NSW, 2011, RERP Report, p.vii).

It specifically secured water for the environment, delivering the water to the following selected five wetlands and lakes, and attempting environmental restoration:

- Macquarie Marshes
- Gywdir Wetlands
- Lowbridgee Floodplain
- Lachlan Wetlands
- Narran Lakes.

Furthermore, in order to achieve such a big aim, four subprograms were built and have pursued the following targets, respectively:

- Subprogram 1 – Acquisition and management of environmental water
- Subprogram 2 – Enabling better use of environmental water
- Subprogram 3 – Better delivery of environmental water
- Subprogram 4 – Partnerships for the management of environmental water on private land.

The flow of the fund of an RERP enterprise which aims at environmental restoration of the selected targets is as follows:

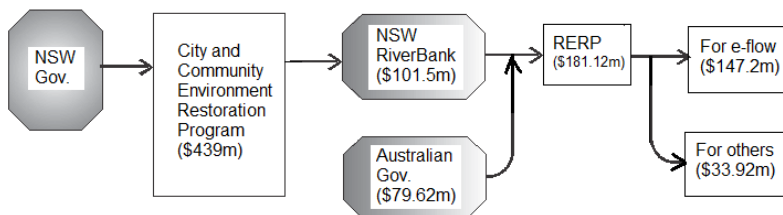


Figure 11.4: the flow of the RERP fund
(Source: created from DECCW-NSW, 2011)

The NSW government started the City and Community Environment Restoration Program to cope with a specific and important environmental problem. It set up a fund of A\$439 million over five years. Of this, A\$101.5 million was invested and RiverBank was established in November 2005.

The purpose of **RiverBank** was as follows:

[It aimed] to buy and manage water for environmental benefits and specifically to protect and restore ailing wetlands and river systems in NSW ... At its inception, NSW RiverBank was the single largest government commitment to restore the health of priority wetlands in NSW and the first program to acquire water entitlements from willing sellers via the water market (DECCW-NSW, 2011, p.1).

The establishment of NSW RiverBank led to the formation of **NERP** in September 2007 with the Australian Government, through its Water for the Future initiative, Water Smart Australia Program, providing A\$79.62 million to support NSW RiverBank.

These funds were used as follows:

- A\$147.2 million to acquire water for the environment.
- A\$8.1 million for management-focused science
- A\$10.1 million for infrastructure to improve water management
- A\$14.8 million for landholder and Aboriginal community engagement, and wetland purchase and protection.

It is recognised that RERP is not only the antithesis of previous river management, but is also an enterprise that further advances water reform in NSW by ten years or more (DECCW-NSW, 2011, p.1).

The execution organisation of RERP was as follows:

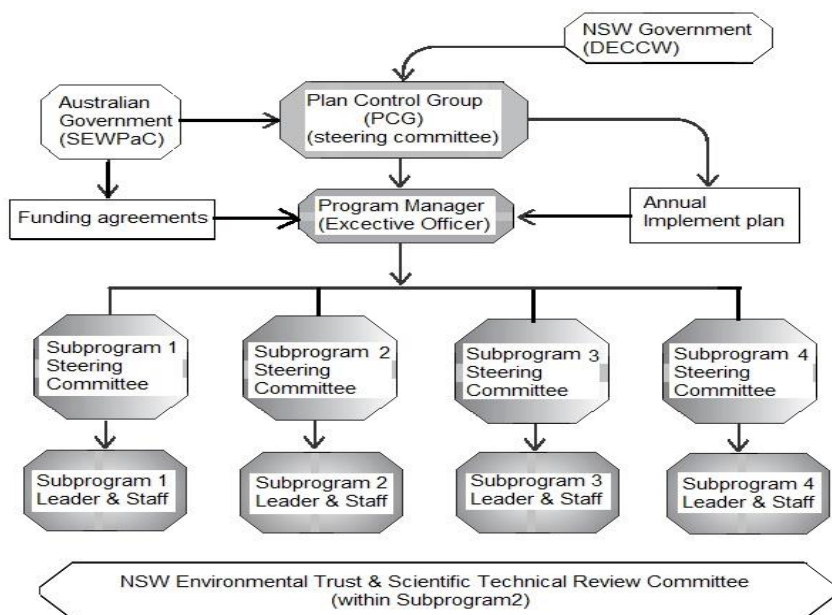


Figure 11.5: architecture of RERP

(Source: created by DECCW-NSW, 2011.

Note: SEWPaC is the Department of Sustainability, Environment, Water, Population and Communities. DECCW is the Department of Environment, Climate change and Water NSW)

A representative from SEWPaC is an observer on the PCG. A program manager employed by DECCW manages the day-to-day business of RERP. The program manager is responsible for

the overall operation and performance of the program, consistent with the funding agreement and annual implementation plan. Subprogram leaders are responsible for day-to-day operation of each subprogram within the parameters set by the annual implementation plan.

11.4.2: Management in relation to MBIs

Although the report provides no details of the market technique used, it is thought that all 108gl of water was gained by purchase from a water market.

For example, in 2011, Macquarie Marshes announced that 42,263ml of water for general security and 140ml of supplementary access entitlements was purchased (DECCW-NSW, 2011, p.8). This suggests about A\$ 14 million is cheap in total compared with the arithmetic average price of a TLM enterprise in the case of a RERP enterprise.

Therefore, it is thought that the RERP enterprise was able to inject more funds into research on how to effectively use the water gained rather for environmental regeneration, without funds being taken by acquisition of water.

That is clear also from the result of subprogram 2 described below.

11.4.3: Outcomes

The result obtained in Macquarie Marshes, one of RERP's first targets, is explained. At the end of January 2011, Macquarie Marshes announced 42,263ml of water rights for general security and 140ml of supplementary access entitlements had been purchased. It is said that this purchased water (combined with purchases under other programs) contributed to increase the environment's share of available water by more than 60 per cent compared with the water sharing plan for this area. Moreover, this significantly improves the ability of government to supply environmental water to core wetland assets and extend the scope of water allocation under the water sharing plan (DECCW-NSW, 2011, p.8). The water gained by RERP was actually provided by Oxley Break and Pillicawarrina. We will quote the case of Pillicawarrina:

Since the purchase, RERP, in partnership with DECCW Parks and Wildlife Group, has invested more than A\$600,000 in the rehabilitation of the Pillicawarrina floodplain. Completed works include removal of banks and channels to reinstate the flow of floodwater across the floodplain, the upgrade of culverts to enhance the passage of floodwaters and fish passage and the installation of a river gauge to improve real-time management and reporting of river flows. A seed bank study and revegetation

strategy, including a monitoring program, has also been developed to guide further efforts to rehabilitate areas previously cleared. Modification of an in-stream structure, to ensure it is fish-friendly, will be completed when high river flows recede ... Environmental flows through August to March 2011 have subsequently inundated the area and wetland species are now regenerating. It is expected that future inundation will result in significant restoration of the wetland ecology, demonstrating the regenerative potential of modified wetland environments (DECCW-NSW, 2011, p.11).

Furthermore, RERP produced the following major results about modeling the amount of water required for the environment, or development of the **Decision Support System (DSS)**:

- Hydrodynamic model (MIKEFLOOD-based) representing water flow through the Macquarie Marshes has been completed (DECCW-NSW, 2011,p.16).
- The Macquarie Marshes EXCLAIM DSS models the ecological implications of climate change scenarios using the water balance model of the Macquarie catchment and the water requirements information.
- The integrated Catchment Assessment and Management (iCAM) centre at the ANU has subsequently developed the IBIS DSS for the Macquarie Marshes under RERP,

which reports on 36 water management areas (storages) using IQQM⁴ as the contributing hydrological model. IBIS is able to run hydrological time series ranging from an individual flow to over 100-years time series, and predict the likely ecological impacts of climate change or water resource development (DECCW-NSW, 2011, p.17).

These results are likely to mean:

The DSS will assist water managers evaluate the long-term effect of rules governing sharing of water between environmental and consumptive users as well as exploring options for the delivery of available environmental water on an event basis (DECCW-NSW, 2011, p.17).

The overall results are summarised as follows:

⁴ IQQM is software designed for use as a basin-wide daily stream flow simulation model for water resource planning and management (DECCW-NSW, 2011,p.16).

Subprogram 1 – Acquisition and management of environmental water

- To January 2011, over 108,000 megalitres of Water Access Licences (WALs) have been purchased through RERP for application to targeted wetlands.
- Watering events in these valleys have supported significant water-dependent biota and contributed the nation's international obligations with respect to wetlands and migratory birds.
- Watering events have occurred during a period of historic low rainfall and low water allocations.
- Representatives of Aboriginal communities have been appointed to the Environmental Water Reference Groups (who provide recommendations on the use of environmental water)

Subprogram 2-Enabling better use of environmental water

- The water requirements of key ecological assets have been determined through inundation and vegetation mapping, ecological monitoring and extensive literature review.
- Hydrological and hydrodynamic models for the Gwydir Wetlands, Macquarie Marshes and Lowbidgee Floodplain have been completed, providing a mechanism for predicting the likely movement of environmental water through targeted wetlands.
- Decision Support Systems have been completed for Gwydir Wetlands, Macquarie Marshes, Lowbidgee Floodplain and Narran Lakes, allowing the prediction of the likely ecological response of key species to different watering scenarios.
- A detailed concept design has been completed for works on Burrendong Dam to reduce cold water pollution (proving the feasibility of the floating curtain concept).
- 29 gauging stations have been installed to provide real-time information to assist in managing environmental flows.
- Ten regulating structures and ten floodways have been constructed and 40 pre-existing embankments have been breached on Yanga National Park to improve the distribution of environmental flows.
- Banks and channels have been removed to reinstate the flow of floodwater across the floodplain on Pillicawarrina.

Table 11.3: results of RERP
 (Source: DECCW-NSW, 2011, p.7)

As mentioned above, we can learn the following from an examination of RERP. In Australia, the water market already serves as an indispensable tool for reserving water for the environment, and it can be said that water for the environment and the water market coexist in a symbiotic relationship. Reservation and the use for the environment of water which utilised the water market have led to the development of a model that enables calculation of the amount of water required for the environment.

Furthermore, development of the model takes into account abnormal weather, such as global warming and drought, foresees change of the environment of up to 100 years ahead and, it could be said, is connected with storing scientific knowledge to aid appropriate decision-making.

Section 5: Activities about other e-flow

Cases other than the above in connection with reservation of water for the environment are introduced.

11.5.1 Lower Broken Creek: Seasonal Watering Program 2012/13

- (1) Target and governance

First, in order to support breeding of the fish in Lower Broken Creek and increase the population, it managed changes in the dissolved oxygen concentration of the creek in the 2012/13 fiscal year irrigation season. Second, to prevent multiplication of the azolla water fern, which is harmful to fish habitats, it utilises water for the environment. GBCMA planned the following six detailed events in order to reproduce a natural environmental flow regime based on old scientific research.

Priority	Flow component	Daily Flow (ML)	Component Volume (ML)	Cumulative Volume* (ML)
1	Mid-August to May fish ladder passage flow of 40ML/day	40	10,900	10,900
2	Mid-August to November Azolla management flow of additional 120ML/day	120	12,800	19,500
3	October to May dissolved oxygen management flows of 150ML/day	150	34,100	39,600

4	December to mid-May high flow of 250ML/day for up to 60 days for DO management	250	22,500	48,600
5	August to November flush of 250ML/day for 14 days for Azolla build-up management	250	7,000	51,400
6	September to December fish habitat / migration flow of 250ML/day	250	30,500	58,600

Table 11.4: the planned events for watering

e-flow of Lower Broken Creek

(Source: GBCMA, 2012, p.14.

Note: *Cumulative volume shows the amount of accumulation except an overlapped part. Total 58,600ml is a necessary quantity in case there is no water for the environment used for others, and because another amount of water can be used, the amount of water secured as water for the environment in the 2012/13 fiscal year is 26,165ml)

The organisation and the role for executing the plan are as follows.

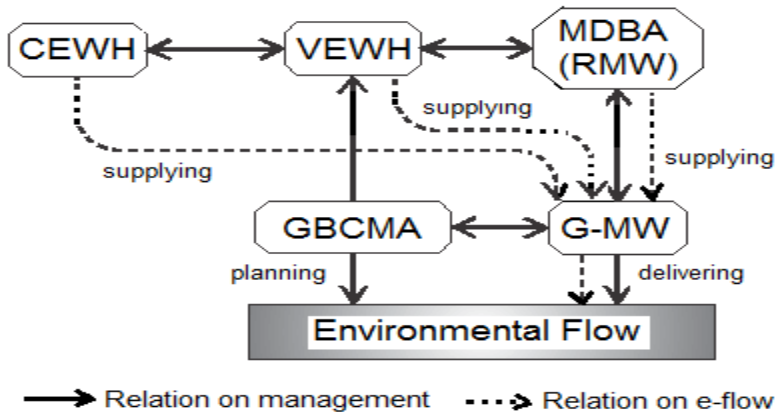


Figure 11.6: architecture of Lower Broken Creek seasonal watering plan
 (Source: created from GBCMA, 2012, Lower Broken Creek: Seasonal Watering Proposal 2012/13)

GBCMA draws up a plan called a seasonal watering proposal which is submitted to VWEH of the Victoria government. VEWH examines its practicality in the light of its administrative plan (i.e. the seasonal watering plan), makes adjustments with various organisations and secures water. CEWH, MDBA and G-MW refer to their plan and determine the propriety of the supply of water. G-MW performs delivery of the water for the environment. GBCMA monitors the effect of the water for the environment. The environmental entitlement holders pay expenses of A\$420,000 to cover delivery of the water for the environment in this case (GBCMA, 2012, p.18).

GBCMA decides the timing for delivery of the water for

environment, and directs the amount of water depending on the amount of water in the creek, climate conditions and seasonal variations flowing for other purposes and the loss of delivery. As a result, the following water for the environment and water for other purposes were poured from August 2012 to May 2013.⁵

Water sources available for the Lower Broken Creek	
For consumptive use	Goulburn & Murray Irrigation supplies (managed by G-MW) Murray River flows (managed by MDBA)
For environmental use	2,388ML (Murray-in-transit water; managed by MDBA and VEWH) 8,216ML (Goulburn Water Quality Reserve; managed by G-MW) 9,803ML (managed by CEWH) 5,758ML (Inter-Valley Transfer; managed by MDBA & G-MW)
Total	26,165ML

Table 11.5: water sources available for the Lower Broken Creek

(Source: created from GBCMA, 2012)

⁵ One flow event was performed in September 2012. The details can be checked in the following webpage: <http://www.vewh.vic.gov.au/news-and-resources/news/spring-flows-to-benefit-fish-in-lower-broken-creek>).

(2) Outcomes

The maximum amount of water for the environment of 250ml was poured by Lower Broken Creek from September 2012 to December. The total amount of the water for the environment serves as 26,165ml. 9,803ml of that was environmental entitlements from CEWH. In the right for the environment of this CEWH water, the water rights supplied from the water market are included.

Over eight years, the fish could be moved using environmental flows and the fishway (also known as fish ladder, fish pass or fish steps) in the irrigation season, and this contributed to helping the breeding of fish. The new aspect of this enterprise is that it uses environmental flow not only VEWH but CEWH. Moreover, this enterprise verifies the effect of the water used for the environment while also using observation equipment to collect scientific data.

11.5.2: The related sites about environmental flow

The measure of an environmental flow is being actively tackled at the catchment level by various public and private organisations.

The related site is introduced.

(1) VEWH

VEWH manages the environmental flow in Victoria. For its

track record and seasonal watering plans refer to:

<http://www.vewh.vic.gov.au/news-and-resources/news>

<http://www.vewh.vic.gov.au/news-and-resources/resource-library/seasonal-watering-plan>.

(2) Snowy River environmental flows

New South Wales, Victoria and the federal government established the Water for River company as a consortium. This company arranges water for the environment based on the Snowy Water Inquiry Outcomes Implementation Deed. A\$375 million was injected in June 2012, 282gl of water for the environment was secured, and 70gl of water is scheduled to be returned to the Snowy River and 212gl to the Murray River. Refer to the following for Snowy River environmental flows 2011:

<http://www.environment.gov.au/water/publications/environmental/ecosystems/video-snowy-river-environmental-flows.html>.

And, refer to the following for Snowy Flow Response Monitoring and Modeling program:

<http://www.water.nsw.gov.au/Water-management/Monitoring/Snowy-River/Snowy-River/default.aspx>.

(3) Murray Wetlands Working Group (MWWG) of NSW

MWWG is a private organisation that manages environmental water under the control of the Water

Administration Ministerial Corporation of NSW. The water under management was 32,027ml. Of this, 30,000ml was produced by Murray Irrigation's leak prevention construction and 2072ml was produced by the improvement of the rehabilitation of water. MWWG performed the environmental improvement by supplying water to flood wetlands directly, and by dealing in a water market and earning funds (refer to PC, 2006, p.195, and <http://www.mwwg.org.au/allocation.php>).

(4) Healthy Rivers Australia (HRA)

Healthy Rivers Australia is a private, independent, membership based, not for profit organisation that works with communities to restore the health of Australia's rivers. HRA has established Australia's largest environmental 'water bank' that holds water either donated by entitlement holders or purchased using funds from donations and sponsorship. This water is made available, on application, to individuals or organisations that propose to use it for riparian ecosystem improvement. Project partners include community groups, schools, companies and volunteers, working together to effectively deliver positive environmental results. The projects HRA supports are approved by relevant government authorities. For its latest activity track record refer to: <http://www.healthyrivers.org.au/projects/> (see Bennett, J, 2012, p.283).

(5) Environmental Water Trust by the NSW Nature Conservation Council (NCC)

The Environmental Water Trust has been established under the auspices of the NCC as a national independent non-government charitable organisation to facilitate investment in the long term environmental health of Australia's rivers and wetlands. The trust's funding is based on tax-deductible donations held in its environmental water fund. The trust purchased water rights of in the Warrego River from the Queensland government using this fund and its water licence. The trust uses this water and is tackling maintenance and reproduction of the Warrego wetlands and riparian floodplains (refer to: <http://environmentalwatertrust.org.au/case-study/>).

(6) Commonwealth Environmental Water Office

Interesting videos about environmental flow can be appreciated at the following site:

<http://www.environment.gov.au/ewater/gallery/video/index.html>

Section 6: Theoretical meaning of environmental flow purchases in relation with the Coase theorem

The Coase theorem makes it possible to apply the market technique of C&T (Cap and Trade) to an environmental problem.

Two types of candidates are considered for selection – money and water resources (water entitlements). Two parties are

involved in the negotiations: a company (F) and residents (R). The company has water rights and we assume residents do not. If the quantity of water entitlements increases, and the quantity of money held increases, it will be assumed there is a high utility level function for company and residents.

Then, the Edgeworth diagram can be drawn as follows.

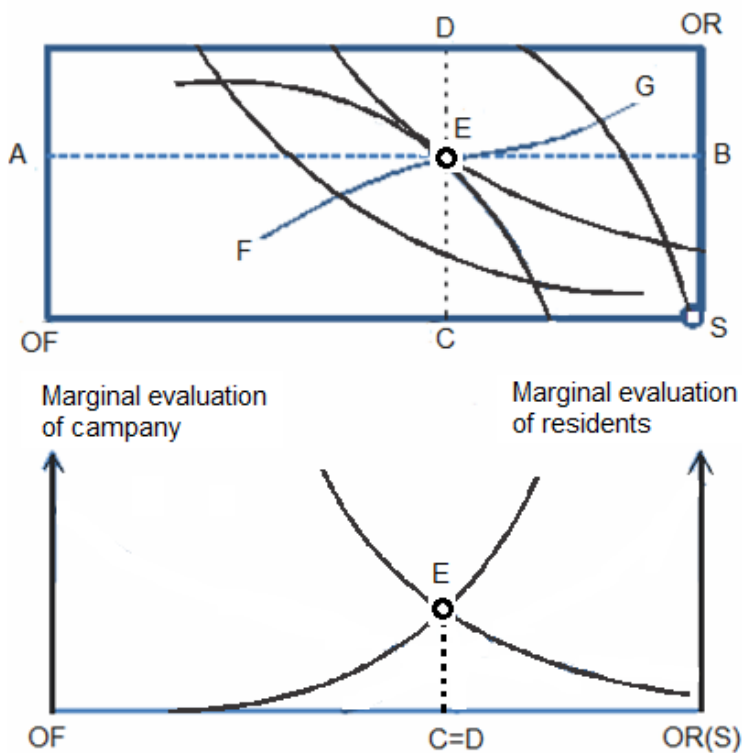


Figure 11.7: Edgeworth diagram and marginal rate of substitution curves

The state of the first resource allocation is shown by the point S. The curve that passes along the point S is each indifference curve, and FG is a contract curve. The lower half of Figure 11.7 draws the marginal rate of substitution of each indifference curve in the contracting point E.

Negotiation starts from the point S. Residents show the amount of money that can be paid and purchase water entitlements from a company. A company sells water entitlements, considering the loss of losing water entitlements. In this way, point E, where the utility level is higher than point S for residents and also for the company, can be shown to be the result of spontaneous negotiation. At this time, the company sold water entitlements CS to residents and obtained the money of $OFA=CE$. On the other hand, although residents lose the money of SB, the water entitlements of ORD are acquired and both conditions are better off.

Thus, the environmental problem (i.e. aggravation of the environment by lack of an environmental flow) that is behind water entitlements trading is also solved through negotiation. Specifically, we can reach a desirable solution by setting ownership (water entitlements) to goods (water resources) and leaving it to spontaneous negotiation between the parties.

This is a fundamental idea of the Coase theorem.

environment itself is the party concerned. Here, it will be called 'environment' (or environment manager) for ease of explanation. In the context of Australia, which includes water entitlements in the environment, this assumption is very natural and realistic (see Section 3-5 of this chapter).

Now, presuppose that the water entitlements that can be distributed to the environment and people is OJ at first. The height of the curve AEFB expresses the quantum evaluation to marginal exploitation of humans' water resources. For example, humans consider that humans should pay the amount of money shown in the area of OAEH, when only OH uses water resources.

On the other hand, the marginal evaluation of the amount of money that may be paid to secure water for the environment is illustrated by the leftward curvilinear CD by making the point J into a starting point. It is possible that marginal evaluation of this environment depends on recognition of the size of active support (for example, donations), or the level of recognition of the seriousness of the environmental problem by residents.

Australia's TLM enterprise conceived of reservation of water by first constructing the infrastructure. Although the expense was comparatively large, this enterprise was able to reduce the amount of money of JKMN and thus secure the water resources of KJ for the environment. Therefore, the amount of water

resources that can be distributed to humans or the environment expanded from OJ to OK. However, the acquisition of water entitlements came to be gradually performed by purchase of water entitlements through water markets and tender.

Fundamentally, the price of water rights could acquire water entitlements for less money than an infrastructure construction enterprise because it is dependent on the size of the marginal net returns of an irrigation farmer. This situation can be explained by there being a line of FG below rather than MN. And the fund of FIJG was injected through TLM's market technique, and the water entitlements of JI were secured for the environment.

Now, the environment has secured the water entitlements of KI according to the result of TLM, or other enterprises. However, in order to maintain the environmental assets of the MD Basin continuously, the scientists claim that water resources of KH are required. Then, the basin plan is created.

Aside from the amount of money, the basin plan is ambitious also in quantity. This plan is going to secure 1468gl/y of water to the existing amount of 1282gl/y ($=1,068\text{gl/y} + 214\text{gl/y}$; see 9.2.5) in acquisition of water. As a result, we have to gain water with a marginal valuation more naturally than before.

Bjornlund *et al.* has pointed out as follows that the purchase of further water for the environment is accompanied by big difficulties:

Surveys of irrigators in 2008-09 suggest that between 40 and 60 per cent of irrigators in the Riverland and GMID (Goulburn-Murray Irrigation District) stated they have not thought about selling water to the government at all ... [A]bout 30-40 per cent of irrigators would consider selling their water entitlements, but only if they were offered 'substantially' more than market prices. In the Riverland in 2008-09, the minimum average price suggested by irrigators for a water entitlement per megalitre was just less than A\$2700, while GMID irrigators' minimum average was a little more than A\$1900 (Bjornlund *et al.*, 2011, p.300).

This situation can be explained by LE being up rather than GF. Therefore, purchase expense will increase by leaps and bounds. (The size is shown by the area of EHIL).

Whether the water which this basin plan seeks can actually be gained will depend on the size of the support of an irrigation farmer (or the industrial world), and residents' environment which can be denoted by CD curve. Although the original Coase theorem gropes for the Pareto optimal solution as an intersection of the curve of AEFB and CD (in this case, AEFB expresses a supply curve and CD expresses a demand curve), it is possible by repeating negotiation of water acquisition in a water market to approach the desired equilibrium point. That is, the first step of point F is the optimal solution and the second step of point E

is the optimal solution, and so on. The process of gaining the environmental flow of Australia can be interpreted as being an application process of the grand Coase theorem which utilised adaptive management and a water market in this sense.

Section 7: Summary and conclusions

This chapter considered the relation of an environmental flow and a water market. It surveyed the concept of an environmental flow in Australia and looked at two examples of the following related with an environmental flow.

TLM secured 500gl of water for the environment in six years and conducted an environmental reproduction experiment. For this reason, although A\$1 billion was injected and the non-market technique was used at first, the market technique gradually came to be used due to restrictions of cost and time. As a result, aims were achieved fundamentally.

Although RERP secured 108gl of water in four years and the environment was reproduced, investment capital provided the fund with A\$181,120,000. The use of the water market led to RERP securing water from TLM for little money.

Both measures can make 'environment' and 'humans' a bargaining party and can be understood to be an adaptation of the Coase theorem, which tries to find a solution for an environmental problem through reallocating water resources.

Moreover, both measures do not stop at environmental regeneration, but also accumulate scientific knowledge about environment management techniques, discover methods of controlling the environment and create applications for solving global environment problems. These achievements of the basin plan and are likely to continue in the future.

An environmental flow is taking the lead in the water environment policy of Australia. This enterprise is also the result of water reform while also opening a new chapter into the future. This is because CMA (and private sector entities) tend to make a plan using the water gained through the water market while water corporations tend to supply water according to the plan resulting in simultaneous acquisition of scientific knowledge and environmental preservation.

Because an environmental flow aims at environmental preservation or reproduction, although there is little negative influence by the environment, salt may flow into a river, for example due to high flow, and may worsen the river salinity. In Australia, the influence was analysed using the model accompanied by timing that avoids influence wherever possible. Furthermore it has used its influence to impose an offset duty using the credit. It is thought that the negative influence on the environment of artificially passing an environmental flow is quite low, and the positive effect on the environment is rather

larger. Therefore, a water market is in a symbiotic relationship with the environment and through the acquisition of an environmental flow.

Tackling an environmental flow can be interpreted as follows. The environmental flow functions as a key for accumulating the knowledge and know-how for environment management. This will consider the general environment and reproduce it, which will lead to a strengthening. It then becomes possible for this knowledge to help old environmental restrictions expand like never before.

Figure 11.9 shows this situation.

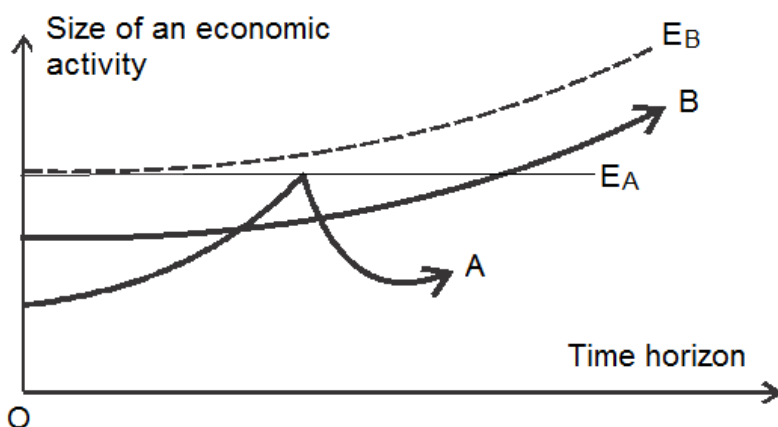


Figure 11.9: long-term optimisation and environmental restrictions

Suppose that there are two economic growth systems, *A* and *B*. Both are holding environmental restrictions called E_A at present. *B* economy explains an environmental secret, and if

environmental restrictions can be raised even to *Eb* by reproducing and strengthening the environment, the growth in the *B* economy is higher than the economy that did not do its best in expansion of environmental restrictions in the long run.

Looked at this way, it is possible that the measure of an environmental flow is a milestone to society that can be continued. The water market offers various goods and services, techniques and means for realising a **sustainable society**. For example, temporary water trading, permanent water trading, interstate trading, carry-over, lease, option contracts, auctions and tenders. Not only the regulated surface water but also groundwater and unregulated surface water are dealt with in the water market or dealing. It is also possible for these to consider a portfolio and to combine variously. By practical use of this portfolio, the flexible practical use of a water market in line with the upheaval of the global environment is attained, and it enables development of further new environment management techniques, including public bodies and private organisations.

Moreover, a sustainable society can be greatly contributed to through the construction of a water market that produces a new system (e.g. an environmental manager, CEWH) and programs (e.g. TLM, basin plan and some projects which private organisations offer).

However, we also have to point out the problems that may

occur. Generally, a water market promotes increased efficiency and mechanisation of irrigation agriculture.

The more a water market contributes to irrigation agriculture economies of scale and to increased efficiency, the more farm labour forces may decrease leading in turn to a decrease in the population of a farming community. Although this is one of the problems facing contemporary capitalism rather than being restricted to the water market, caution will be probably required to deal with it. However, although the population of agricultural communities is decreasing at present, it is unknown how this is directly related to the water market (refer to Section 3 of Chapter 12 about this point in detail).

This chapter has clarified these points as follows:

1. It showed that a water market and the environment have a symbiotic relationship concerning an environmental flow.
2. It showed how CMA, water corporations, CEWH, and VEWH are related in the practical use of an environmental flow.
3. It showed that the acquisition of an environmental flow is an application of the Coase theorem.
4. It showed that a water market, through the use of an environmental flow, has played an important part in the construction of a sustainable society.

Chapter 12

Impacts and Evaluation of Australian Water Reform

Section 1: Introduction – birth of the ‘Australia model’

Water reform centring on the Australian water market already has about 30 years of history. It came into being as a result of the drought and started in the closed area (irrigation district) early in the 1980s, amendments were made to the legal system at the end of the 1980s and permanent trading (original water entitlements trading) also started in 1991 (in Victoria). With the introduction of the Cap system in 1995 and restrictions on diversions from the Murray because of prolonged drought, water trading entered an era of rapid progress. The federal government implemented a policy of positive support and water trading expanded to all the states. With changes in the water environment brought about by drought and global warming, the federal government decided to implement a national water strategy (NWI) and led further reform in 2004. The Victorian government unbundled water rights into three components of water share, delivery share and water-use approval, in 2007, and a carry-over system and the purchase of water for the environment were introduced. The MDBA was founded in 2008 and the Basin Plan introduced. Further evolution towards the

construction of a sustainable society occurred through as the introduction of integrative management of groundwater and surface water, and environmental regeneration which utilised the water for environment.

A report on the influence of water trading and the water market was published by the National Water Commission (NWC) in June 2010. Similarly, *Water markets in Australia: a short history* was released by the NWC in 2011.

Australian water reform (centring on the water market) has now reached a time of economic, social and environmental evaluation. Or it could be said that experience over 30 years makes it suitable to call it the ‘Australia model’. While models simultaneously summarise old experiences and check the final outcome, it is also possible to extract lessons for further advances.

In this and the following chapter we evaluate Australian water market reform and water reform in general. In this chapter, we perform an external evaluation based on objective data. In the following chapter, immanent evaluation is performed based on the measurement of an economic surplus. Section 2 of this chapter introduces and considers the NWC’s evaluation of the Australia model. In Section 3, we consider the long-term influences the water market had on society. In Section 4, Section 5 and Section 6, when drawing the Australia model, we examine

four key factors which made a major contribution, i.e., state government, a water company (water corporation), CMA and MDBC/A. Water trading is also explained in the abstractive. Section 7 summarises the teachings and features of the Australia model in five main points.

Section 2: Analysis of the NWC

In June 2010, the National Water Commission (NWC) published a report titled *The impacts of water trading in the southern Murray-Darling Basin: An economic, social and environmental assessment*. This deserves attention as the first full-scale evaluation by the most authoritative organisation. Although the 11 years from 1998–99 to 2008–09 are set as the main evaluation period, this period overlaps a year-long drought. In economic impact evaluation, a model (called ‘TERM-H2O CGE model’ or just the ‘CGE model’) that can pursue and reproduce the situation of water trading was created and two cases, that is, *with* water trading and *without* water trading, were compared. The economic effect of the water rights market was quantitatively presumed by measuring the difference. In social impact evaluation, in addition to analysis of a socioeconomic index, influence on individuals and influence on the whole community were verified by questionnaire and interview. In environmental impact evaluation, although excepting the

influence of the latest large-scale water purchase for the environment by the federal government, consideration was limited mainly to the level of salt water damage to the whole Murray-Darling Basin. The NWC's *Short History* of 2011 is an evaluation of the Australia model.

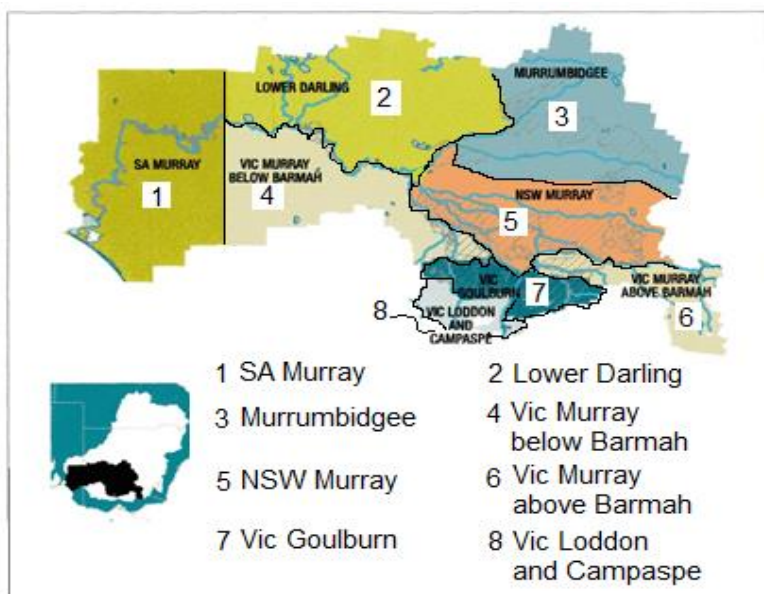


Figure 12.1: regions in the southern Murray-Darling Basin
(Source: NWC, 2010a, p.5, partly modified)

We will check the transition of the dealings amount of water trading (both allocation water trading and entitlements trading are included) in the southern MDB in an observation period. In the NWC's data (from the first data of MDBA), although water

trading of unregulated river and groundwater were not included, it applied in 1998-99 to 2007-08, and increased by 42 per cent from 537,442ml to 763,894ml in allocation trading.

Comparatively stable permanent trading (entitlement trading dealings) increased rapidly from 36,436ml for 2005-06 to 387,640ml for 2007-08 (NWC, 2010a, p.19). The water allocation proportion traded for the total amount of the distributed water of the period was increased to 24 per cent from 6 per cent (NWC, 2010a, p.21. Also refer to Section 6 of Chapter 1).

Thus, although water trading was accompanied by comparatively big yearly change, it had increased as a trend, but a still bigger change took place from 2007-08 and 2008-09.

According to the Australian Water Markets Report, water entitlement trading is increasing no less than 116 per cent to 1080gl from 500gl. In allocation trading, it is increasing 58 per cent to 1739gl from 500gl (NWC, 2010a, p.20).

Although the water allocation proportion traded beyond the area for the whole dealings up to 2004-05 was as small as 10 per cent or less, it increased steadily after that. Moreover, the huge expansion of water entitlements dealings in these days depended mainly on the increase in dealings inside the area (NWC, 2010a, Figure 11, p.42 and Figure 13, p.44. In addition,

Section 5 of Chapter 1 introduced the situation in the latest water market).

12.2.1: Economic impacts

Next, the economic impact in an individual area is described.

Table 12.1 expresses the total agricultural output amount in eight areas at 2000–01 and 2005–06, all the amount of water used, and water trading inside the area. (Areas where the amount of agricultural output increased although the amount of water used decreased are shaded).

Area	Item	2000–01	2005–06
NSW Lower Darling	agricultural output (\$M)	216	219
	water used (GL)	68	98
	water balance (GL)	20	0
	inside trading (GL)	n.a.	21.8
NSW Murrumbidgee	agricultural output (\$M)	961	931
	water used (GL)	2719	2138
	water balance (GL)	-30	-6
	inside trading (GL)	152.9	102.7
NSW Murray	agricultural output (\$M)	838	879
	water used (GL)	2378	2034
	water balance (GL)	0	3
	inside trading (GL)	107.8	154.4

SA Murray	agricultural output (\$M)	1203	1222
	water used (GL)	880	869
	water balance (GL)	13	-4
	inside trading (GL)	0.7	49.1
Vic. Goulburn	agricultural output (\$M)	958	1068
	water used (GL)	795	796
	water balance (GL)	3	-22
	inside trading (GL)	142	164
Vic. Loddon and Campaspe	agricultural output (\$M)	157	131
	water used (GL)	558	589
	water balance (GL)	-4	38
	inside trading (GL)	4	5
Vic. Murray above Barmah	agricultural output (\$M)	573	629
	water used (GL)	2008	1526
	water balance (GL)	-1.6	3.8
	inside trading (GL)	6	20
Vi. Murray below Barmah	agricultural output (\$M)	1116	1040
	water used (GL)	2008	1526
	water balance (GL)	-2	6
	inside trading (GL)	21	69

Table 12.1: the amount of agricultural output, amount of the water used, and water trading volume 2001–01 and 2005–06
(Source: NWC, 2010a, p.57, Table 4)

In many areas, although agriculture reduced the use of water because of a drought from 2000–01 to 2005–06, output relative

to water use increased. For example, the agricultural output of the Murrumbidgee area showed a slight reduction from A\$961 million to A\$931 million (without adjustment for inflation), although the amount of water used decreased by 21 per cent from 2719gl to 2138gl. The same thing was seen at Barmah, in Victoria in the downstream Murray area. Furthermore, according to Table 12.2, it turns out that the rate of change of the local water balance due to water trading, relative to the amount of water used in the area, is very small. As a whole, the data of Table 12.2 supports the hypothesis that the reduction in the amount of water used does not lead to a proportional reduction of agricultural output on the level of the area (NWC, 2010a, p.71).

Figure 12.2 summarises Table 12.2. The amount of the water used decreased by 16 per cent (by drought) from 2000–01 to 2005–06 in the whole southern MDB, but it turns out that the amount of agricultural output increased by 1.6 per cent (refer to Figure 12.2).

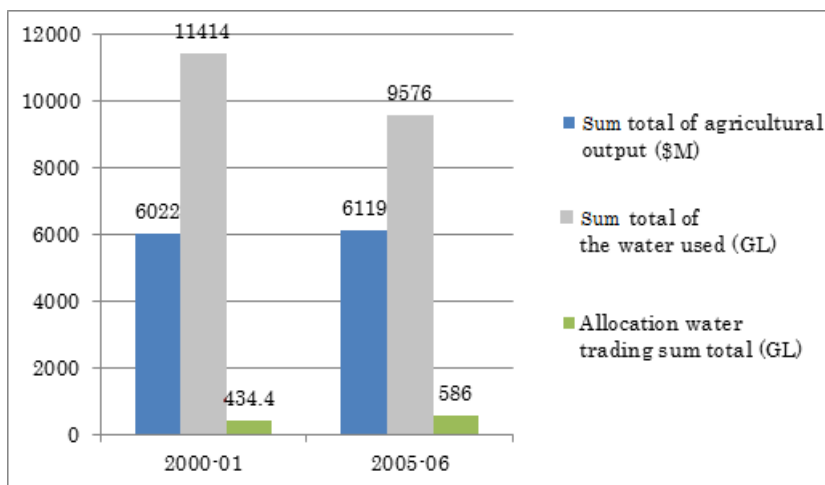


Figure 12.2: change in agricultural output in the southern MDB (eight areas) and the amount of the water used, 2000-2005
(Source: created from Table 12.1)

Table 12.2 illustrates the flexible outcome for water supplies as a result of water dealings. According to Table 12.2, although the farmland area for rice production changes a lot with the change of water distribution every year, on the other hand, it turns out that the land area for citrus trees and grape vines (therefore, the amount of the water used) is stable in spite of drought.

	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
Final water allocation	38%	41%	40%	54%	10%	13%
Irrigated rice area (ha)	17 799	16 760	7 536	27 437	2 744	64
Irrigated citrus area (ha)	8 513	5 090	8 364	8 423	8 434	8 258
Irrigated vines area (ha)	14 482	13 044	16 798	17 151	18 160	18 866

Table 12.2: crop area variation in the Murrumbidgee Irrigation District, 2002-03 to 2007-08
(Source: NWC Report, p.60)

It is thought that the rise in water price because of drought also benefitted the rice farms. In spite of big reductions in rice production, as Table 12.2 shows, the middle prices of the distribution water of the Murrumbidgee area of NSW were A\$566/ml in 2007–08 and A\$375/ml in 2008–09. On the other hand, the gross profit (income minus operational expenses) for rice is about A\$100–200 per ml. It suggests that the rice producers could sell water for more than their gross profit per ml, and this has improved their incomes (NWC, 2010a, p.60).

Next, the overall influence of economic impact is described.

Actual data includes the influence of economic factors other than water trading, for example natural factors such as global warming and drought, international agricultural prices, or input-goods prices, and social effects, such as the change of a governmental water policy or a social situation. In order to grasp only the economic impact of water trading, it is necessary to assume factors other than water trading are fixed, and to measure performance in cases where there is water trading with cases where there is no water trading. For this purpose, the TERM-H2O CGE (computable general equilibrium) model was developed and used.

This model consists of 35 industries (17 kinds of farms, 10 irrigated land divisions, 22 areas, and 28 products are included), and if water decreases, the irrigation farm can reduce the amount

of the water used and sell water provided they meet at least one of the following conditions:

- (1) an irrigation farm where the object for the water supplies per unit products is high
- (2) an irrigation farm where the ratio of water cost to all the costs is high
- (3) an irrigation farm that can use water substitutes easily (for example, feed, such as grass, can also be purchased from a market, although it is also producible by itself).

If water moves between the areas, labour and capital will also move, the level of production increases in the area of water import, and it is assumed in the shipment area the production level will fall (refer to NWC, 2010a, Appendix C).

As in a CGE model, shown in Table 12.3, 2005-06 is assumed as a base year. Water use decreases gradually, considering 2007-08 and 2008-09 as the bottom by a drought from a base year, and it is assumed that it recovers. A simulation of both cases, with and without water trading, is carried out. The difference between the scenarios proves the economic effect of water trading. Needless to say, this scenario assumes a long-term drought of a year.

The main assumption of a CGE model is as follows:

- (1) As shown in Table 12.3, assume the scenario for water availability.

(2) The prices of input goods and outputs goods do not change.

(3) Consider only the water trading between irrigation farmers and do not take cities or other non-agricultural industries into consideration.

(4) It is assumed that a water user's action in various industries is standard (NWC, 2010a, p.84).

Year	NSW Murrumbidgee	NSW Murray	Vic Lower Murray	Vic Loddon- Campaspe	Vic Goulburn
2005 –06	100.0	100.0	100.0	100.0	100.0
2006 –07	67.0	65.0	78.0	65.0	65.0
2007 –08	50.3	50.0	50.0	50.0	50.0
2008 –09	50.3	50.0	50.0	50.0	50.0
2009 –10	66.9	66.7	66.7	66.7	66.7
2010 –11	83.4	83.3	83.3	83.3	83.3
2011 –12	100.0	100.0	100.0	100.0	100.0

Table 12.3: water availability scenario in the

CGE model, 2005-06 to 2011-12

(Source: NWC, 2010a, p.83, partly modified)

The result of every area in cases with and without water trading is shown in NWC, 2010a, Figure 31, p.188 and Figure 32, p.189. In order to illustrate this result intelligibly, Table 12.4 extracts and compares the result of the Eastern Mallee area of Victoria.

	2005– 06	2006– 07	2007– 08	2008– 09	2009– 10	2010– 11	2011– 12
With	Base year	-3.9%	-7.7%	-10.5%	-2.3%	-2.0%	-1.9%
Without	Base year	-3.5%	-9.6%	-12.9%	-3.6%	-3.1%	-2.9%
Water trading effect	0%	-0.4%	+1.9%	+2.5%	+1.3%	+1.1%	+1.0%

Table 12.4: comparison of cases with and without water trading in the Eastern Mallee area of Victoria

(Source: created from NWC, 2010a, Figure 31, p.188 and Figure 32, p.189)

According to Table 12.4, when there are no water dealings, as compared with a base year, there will be a 12.9 per cent reduction in the value of production in this area (Victoria. Eastern Mallee) in the 2008–09 year, for example; but when there is water trading, it turns out that it is a 10.5 per cent reduction, i.e. there was 2.5 per cent ratchet effect.

The trial calculation of the influence on GDP at the national level and the southern MDB level is made by Table 12.5. According to Table 12.5, the trial calculation of the influence on the national level is made with A\$223 million, and the influence on the local level of GDP (A\$370 million) is larger than the national level of GDP in 2008–09.

	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12
Whole national	Base year	59.8	191.5	223.6	107.2	86.2	75.6
Whole sMDB	Base year	81.2	274.8	370.9	237.3	205.2	194.9

**Table 12.5: the production effect of water trading
from 2005–06 to 2011–12 with GDP at A\$1 million
(Source: NWC, 2010a, Table 8, p.84)**

The NWC report summarised the economic effect of water trading at the national level as follows:

- Finding 27: The modelling estimated that water trading in the sMFDB increased Australia's gross domestic product by more than A\$220 million in 2008-09. The total benefits were even greater with the sMDB, where water trading increased gross regional product by more than A\$370 million in that year, including that water trading maintained productive capacity within the sMDB rather than seeing it move to other areas of Australia. Water trading provides benefits during periods of increasing

water scarcity and when water availability is improving (NWC, 2010a, p.84).

On the other hand, there is big local variation in the economic impact of water trading (refer to Fig.12.3 for the details). The NWC report described the variation for every state as follows:

- Finding 28: Net benefits in 2008–09 were A\$79 million in NSW, A\$16 million in South Australia and A\$271 million in Victoria. The modelling does not consider impacts on the urban sector, which could be large, particularly in South Australia (NWC, 2010a, p.85).

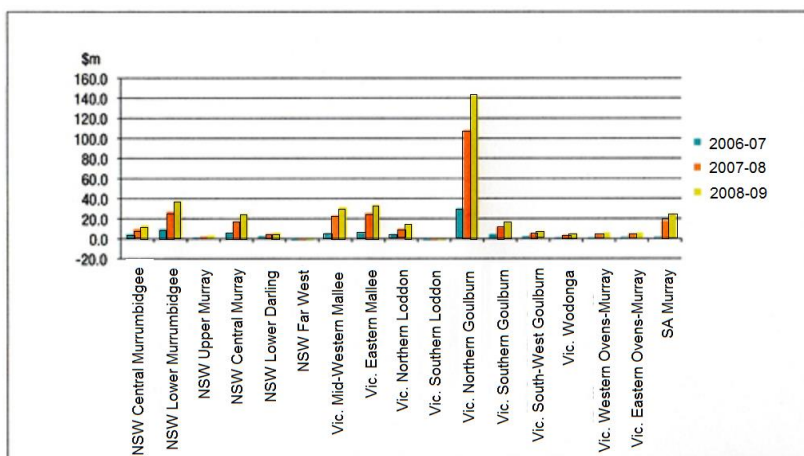


Figure 12.3: modelled production benefits from water trading under reduced water availability, 2006–07 to 2008–09
(Source: NWC, 2010a, p.86, partly modified)

Next, analysis is conducted of the influence on each water user as follows:

- Water trading has enabled more flexible production for each irrigation farmer (both as a seller and a buyer), when external factors (for example, the availability of seasonal water, change of a goods price or an input-goods price, change of governmental water policy and change of society) are managed. This pliability has improved their cash-flow, debt and risk management (NWC, 2010a, p.vi).
- Allocation trading was useful when managing the seasonal change during drought. Allocation water trading actually increased by 42 per cent from 537gl in 1998-99 to 764gl in 2007-08 in spite of a big change in seasonal water. Typically, sellers of allocation water received cash and this was used to overcome drought and to manage debt in certain cases. On the other hand, buyers who obtained allocation water maintained production or protected the productive long-term use of property by taking advantage of perennial cultivated plants and it making it possible to continue production (NWC, 2010a, p.vi).
- Surveying water trading behaviour, Oliver *et al.* (2009) revealed that in 2006-07, in all regions, revenue from water sales provided a substantial boost to farm incomes for many net sellers. The average receipts from temporary water sales for net sellers ranged from A\$22,400 a farm in the Murray region (8 per cent of total cash receipts) to A\$90,800 a farm in the

Loddon-Avoca region (19 per cent of total cash receipts) (NWC, 2010a, p.27).

- Trading in water entitlements was useful also for long-term change. Sellers of water entitlements became opportunistic irrigators, or gave up their business in irrigation agriculture completely. Buyers developed new irrigation enterprises or improved the reliability of their water supply (NWC, 2010a, p.vi).
- Water trading benefited irrigators in all the major irrigation industries in the sMDB (NWC, 2010a, p.vi).

We can conclude that actual water trading produced big economic benefits to persons concerned with both, as Section 6 of Chapter 3 analysed theoretically. The benefits can be said to be especially remarkable at the time of drought.

12.2.2: Social impacts

The NWC evaluated the social impacts as follows:

- Water trading affects water use on the area and at a local level. However, reduction of water in the area originating in water trading in most cases is 10 per cent or less of the whole water use, and this is smaller than the reduction of water supplies by a drought. Redistribution of 10 per cent or more of water took place from Victoria's Goulburn or the Murrumbidgee of NSW

to Victoria's Sunraysia (an area downstream of the Murray from Barmah) and SA in 2007-08 and afterwards. However, according to analysis of the irrigated land division subdivided from Victoria, it was shown that the reduction of water use by water trading in most areas is quite small. Even if water use of the area falls, as shown in the analysis of the production and water use data (refer to Table 12.2 and Figure 12.2), it can be said that an area's reduction of water use does not result in a proportional reduction of agricultural output value. This is because water moves to a worthier place. Moreover, a farm is not totally in a defensive position as it is able to turn to dry land farming to reduce water use. Instead of water, it can inject other things (for example, feed), or can improve water-use efficiency in managing their farm. Water trading maintained production of some expensive value industries, and has decreased production of low-merit industry in the whole southern MDB (NWC, 2010a, p.vii).

- The pattern of dealings and a comparison of main socioeconomic indices show that no discernible link between the pattern of net import and net export of water into the area by water trading, and the population or number of agricultural employers, or weekly household incomes. On the contrary, it was discovered that the history of water trading relative to these observed main socioeconomic indices was the same as occurring anywhere. For example, although farmers decreased in number in all the areas, whether these areas were the net

importer or net exporter of water makes no difference.. The Murray area of SA showed the greatest reduction in farmers from 2001 to 2006. However, this area was a net importer of water during that period. This suggests that factors other than water trading caused big socio-economic change on a local level in 2006 from 1996 (NWC, 2010a, p.vii).

Irrigation Area	Cumulative Net Entitlement Trade 1991/92 to 2006/07 (permanent trade)	Change
Shepparton	-17,154	-9.3%
Central Goulburn	-35,316	-9.0%
Rocester	-9,045	-4.8%
Campaspe	-1,311	-6.2%
Pyramid-Boort	-40,521	-16.5%
Murray Valley	-1,675	-0.6%
Torrumbarry	-50,284	-12.4%
Goulburn System Diversions	-4,178	-3.8%
Murray System Diversions	-9,403	-8.2%

**Table 12.6: net water entitlement trades
for individual irrigation areas within G-MW**

(Source: Australian Government, 2009, Water Trading Tool Kit, p.23)

Table 12.6 limits itself to the area which G-MW in Victoria has managed using data with another NWC, and looks at the water

balance of the area for 15 years. It shows that the management area of G-MW of north Victoria was the net exporter of water on the whole for 15 years, especially in the Pyramid-Boort area with a 16.5 per cent change, producing a large outflow.

The NWC analysed the outflow of water in the Pyramid-Boort area as follows:

- The Goulburn area which is one of the management areas of G-MW of northern Victoria was favoured by agricultural workers and experienced a population growth rising from 8 per cent in 1996 to by 15 per cent in 2006. By contrast, the population of North Loddon (Pyramid Hill and Boort) decreased by about 20 per cent, although 50 per cent were employed by the agricultural sector. This area experienced a net outflow of water trading during the period which saw a reduction in the availability of water as the whole during the drought years of 2002-03 and 2006-07. These net outflows of water trading may have played a role leading to the changes which the Pyramid Hill and Boort community is continuing to experience. However, it is said that the greater portion of net outward dealings in this area concern essential aspects of management of the land and water i.e., the quality and salt concentration of soil. Damage from salt water means the area's productivity is low compared with other irrigated land divisions (NWC, 2010a, p.67, Figure 28, p.54 and Figure 33, p.55).

Although the outflow of water and reduction of the farm population increased in the Pyramid-Boort area, there was a fall in land productivity by damage from salt water and it can be said that the outflow of water surfaced as the result rather than the cause of water trading. The relation of local change and water trading cannot be checked in any areas other than Pyramid-Boort. For example, although the population growth rate of Rochester (with an agricultural worker population of 30 per cent) is the same in 1996 and 2006, the amount of water used is higher than general by the allocation water trading. The local change in the amount of water used by Shepparton and Central Goulburn irrigated land divisions was small, especially when contrasted with change by drought (NWC, 2010a, p.67, Figure 28, p.54 and Figure 33, p.55).

Although Pyramid Hill in the Goulburn area of Victoria has continued selling water consistently every year, the residents of Pyramid Hill claimed that there was speculation in a water market:

- Many dry-land-farmers could purchase land by trust and they sold off water from there, paid land cost and liquidated the debt. Such actions surely actually ruined the agricultural area. It is stated that there were four farmers in the area who went through this process repeatedly (NWC, 2010a, p.71).

At present, clear conclusions cannot be drawn about the influence of water trading on the social aspects, especially the population, of a community. Although it is thought that water dealings have both positive and negative influences on a community, factors other than water trading, such as drought, urbanisation, general business conditions, aging population, agricultural policy and immigration, have had big influences on local populations.

The worst-case scenario is assumed to be one in which structural changes in irrigation agriculture are accelerated by water trading, and the scale of agriculture increases with improved agricultural labour productivity by monopolistic enterprise. Then, the employees engaged in irrigation agriculture decrease in number and farming communities decline. However, as Section 4 of Chapter 4 (4.4.2.1) also described, as long as the present scale of production attains the minimum optimal level, the possibility is low that agriculture will be occupied by the monopolistic enterprise or that the number of employees will decrease. If irrigation agriculture is important for the Australian economy, even if a decline in farming communities occurs, it is unthinkable to neglect this politically (also refer to Section 3 in this chapter).

In addition, the *Short History* of the NWC has described the possibility of the appearance of new water barons:

- There has been an increased entry into the water market of corporate agribusinesses and other Australian and international investors (NWC, 2011a, p.81).

However, the NWC simultaneously warns against the excessive evaluation of new water barons:

- The Select Committee on Agricultural and Related Industries recently recommended that an audit be undertaken to establish the extent of foreign ownership of commercial agricultural and pastoral land, and ownership of water, in Australia ... Many fears about foreign ownership are likely to be overstated, as foreign buyers still have to get a return on entitlements and ultimately that means using or trading the allocations to those entitlements (NWC, 2011a, p.96).

As mentioned above, the water market's adverse influence on society is not so serious at present.

12.2.3: Environmental impacts

The NWC analysed the influence on the environment as follows:

- Water trading between users can have an environmental impact only when a change in ownership results in a change in the timing or location of water use. Modelling of trade-related changes in use revealed that those effects are usually small compared with the impacts of drought and river regulation. Water trading has generally moved water downstream, leading to environmentally beneficial increases in flows at the ends of many tributaries. Hydrological assessments indicate no detectable impact of overall water trading patterns on key ecological assets in the sMDB, including The Living Murray Icon sites, Ramsar-listed wetlands and nationally important wetlands (NWC, 2010a, p.viii).
- Water trading increased in-stream salinity in the Murray over the study period.¹ However, policy instruments such as the Basin Salinity Management Strategy and site use licences have adequately managed and offset the salinity impacts of trading (NWC, 2010a, p.viii).

The *Short History* of the NWC analysed the influence of the government purchase of the water for the environment as follows:

¹ New irrigation developments within each state in the Mallee cause annual increases in average river salinity of 1.8-11.9 EC. NWC, 2010a, p.223.

- The water price (entitlement prices) experienced a 13-18 per cent rise. This high price has an effect of plus and minus. The plus effect is that the profit from the sale of water entitlements increases. On the other hand, people may leave a community after having sold their water entitlements. It may reduce the expenditure in the area and have a minus influence on the regional economy (NWC, 2011a, p.85).
- If water entitlements are sold, the infrastructure holding cost of a left-behind farmhouse increases, the average price of water may be increased, and farm management may worsen (NWC, 2011a, p.87).

However, such influences are so far considered only as possibilities and have not been verified as occurring. Moreover, as 12.2.2 described, various factors other than the water market determine whether an irrigation farm is sold and whether the farmer retires from water rights and where the farmer moves upon retirement. On the other hand, as Section 7 of Chapter 11 described, use of water for the environment preserves the environment, knowledge about environmental preservation is increased and it is effective in reducing the cost of future environment management. Moreover, environmental strengthening enables sustainable development and has the long-

term effect of maintaining economic growth. As seen in Chapter 10 and Chapter 11, the Australia's environmental policy is gaining another policy instrument through the MDBA or CMA to deal with salt water damage or environmental degradation.

If these are judged synthetically, the negative effect of a water market on the environment is at present small. Also the effect of a water market that coexists with environmental preservation is beneficial in the long run. However, future continuous examination will probably be required, especially with global warming having an important impact on the water market.

12.2.4: Integrated evaluation

Based on the above examination, the NWC is described as follows:

- This study demonstrates unequivocally that water markets and trading are making a major contribution to the achievement of the NWI objective of optimising the economic, social and environmental value. The overwhelming conclusion of the study is that water trading has significantly benefited individuals and communities across the sMDB (NWC, 2010a, p.v).

Moreover, the *Short History* estimates the present achievement of a water market as moderate, as follows:

- Australia has not yet reached the point where water markets are operating within a Cap that reflects a sustainable level of extractions and ongoing uncertainty has obvious implications for the objective of providing entitlement holders with confidence and security to make investment and adjustment decisions (NWC, 2011a, p.101).

That is, it has not yet established whether the Australian water market is sustainable and further improvement and refinement to the uncertainty of water entitlements is required.

In response to the above examination of the NWC, we will try our evaluation.

As the NWC analysed, the Australian water market brought about big results and achievements in three fields: economy, society and environment. However, although the water market has a few bad influences on the environment, aggravation of the river environment by superfluous use of the MDB still continues. This point is connected also with the problem of the SDL (**Sustainable Diversion Limit**) of the basin plan redefining Cap. Trying environmental restoration by use of water for the environment has only recently started and, in addition, future periodical verification of the change of the long-term

environment is required, including evaluation of the effect of the basin plan or of water for the environment.

However, as the NWC's evaluation has stated, the problem with the aggravation of environment by a water market have not so far occurred. Conversely, the water market extended the choice of irrigation management in abnormal circumstances, such as droughts, and the water market fully functioned as a means of risk management.

It clearly has had a prominent economic effect in achieving production expansion through the efficient utilisation of water without a new water supply. Moreover, in spite of being such a large-scale water market, a major social problem has not arisen. The cost of starting a new system is large, and the intervention of administration does not necessarily become unnecessary. Moreover, as the NWC has stated, institutional completeness is further increased and though new subjects occur (groundwater, option transactions, risk management) that should add refinement, the experience for these 30 years can be evaluated as a big success which can be said to be the birth of new global standard model of water resources management.

It is a huge market of a scale extending beyond a single state, rather than being a water market for specific participants in specific areas. It is estimated that the spread of participants other than irrigation farmers, the diversity of goods currently dealt

with, reduction of the transaction costs through using the internet, the symbiotic relationship between water market and environment etc. are sufficiently unique that it should just be called the '**Australia model**'.

Section 3: Long-term influences of a water market

The NWC analysis examined in Section 2 was conducted from the viewpoint that the water market was able to stop the influence of a drought. This is fundamentally a short-term analysis. Therefore, we would like to analyse some data to determine what kind of influence the existence of the water market over 30 years has had on Australia's economy, society and environment, and to explore its long-term influence.

(1) Influence on agricultural output

We will first examine the water market's influence on agricultural output. Table 12.7 sets 1980 to 100 and compares the change every ten years. This shows that the value of production of all irrigation agriculture increased by 2.8 times in these 30 years. It turns out that this exceeds the increase (2.6 times) of the GDP, and an even bigger increase, of 4.5 times, is indicated in the export of agricultural products. (A stagnation tendency is seen a little in 2002 and afterwards). Agricultural establishments decreased to three fourths in these 30 years, and a scale expansion has arisen. On the other hand, although a

downward tendency is seen in the number of agricultural employers, it remains a comparatively small reduction.

From these facts, it can be said that agricultural global competitiveness has been strengthened relatively.

	1980	1990	2000	2010
Gross value of farm production (real)	100	146.1	201.7	285.8
GDP (real)	100	136.8	192.6	261.4
Total Export (real)	100	178.9	375.3	479.2
The rate which accounts for the total export of farm export (%)	75.10	66	93.80	71.50
Agricultural establishments	100	90.4	80.0	76.4
Rural employment	100	104.4	104.2	84.9
The ratio of the export to GDP (%)	11.7	15.3	22.9	21.5

Table 12.7: long-term changes in connection with agricultural output

(Source: Based on ABARES, 2012, Agricultural Commodity Statistics)

Next, the labour productivity of the whole economy is compared internationally, as shown in Figure 12.4 (1995 was set to 100).

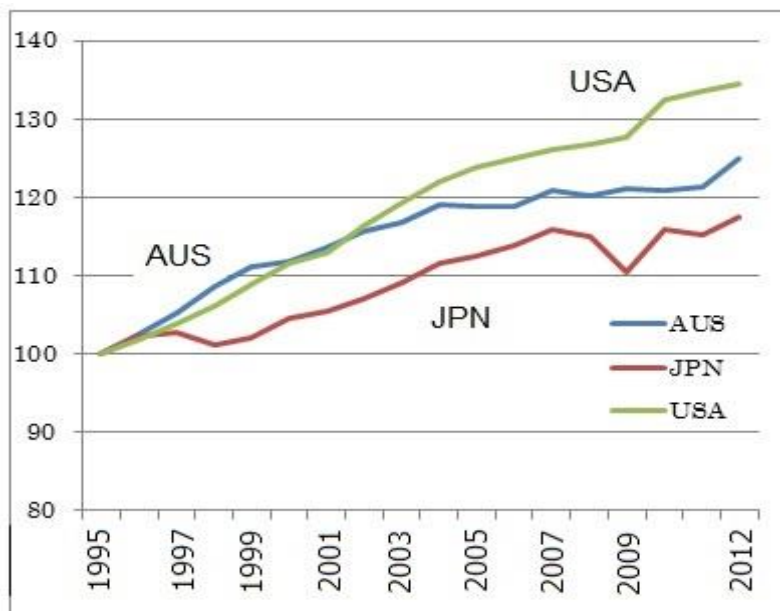


Figure 12.4: transition of labour productivity in the total economy
 (Source: created from OECD, 2012, Economic Outlook)

Although this shows a slowdown tendency in 2004 and afterwards, a big increase in efficiency was especially attained in the whole Australian economy in the second half of the '90s.

Moreover, the NFF (National Farmers' Federation) described the improvement in agricultural labour productivity for these 30 years as having exceeded other sectors:

The growth in the farm sector had increased steadily over the 30-year period from 1974–75 to 2003–04 at an average rate of 2.8 per cent, consistently out-performing other sectors (NFF, 2012, p.5).

According to the NFF report in 2012, the ratio of government subsidy to the rough income of farms for Australia was 4 per cent, for Japan 47 per cent and the United States 9 per cent, and it turns out in Australia that international and autonomous management of farms was realised (NFF, 2012, Farm Facts, p.17).

As these facts show, the efficiency of Australian agricultural output increased in these 30 years and conditions improved for self-supporting business. As Chapter 7 examined, the water market was one of the important factors regulating changes in farm management. This is because the water market can reform the cost-consciousness of irrigation farms through water price, and standards can be set for efficient management.

(2) Influence on communities

Next, we will consider the influence on communities. According to World Bank data, a reduction in the population of agricultural villages has occurred with the progress of urbanisation (refer to Table 12.8). However, there has not been a very big change in the rural population in Australia. In comparison, the reduction in the population of agricultural villages in Japan without a water market is conspicuous.

It is thought that this is because the expansion of agricultural output caused an increase in staffing demands up to at least 2000, thus negating the personnel reduction effect of the increasing

scale of farms. There were also other factors such as drought, general business conditions, an immigration policy. At present, as the NWC also described, even if looked at in the long run, it is not proven that the water market influences the decrease in a community's population.

	1992	1996	2007	2011
AUS	14	14	11	11
JPN	22	22	12	9
USA	24	22	19	18
CN*	72	68	55	49

Table 12.8: rural population / total population (per cent)

(Source: based on World Bank data, 2012. *CN=China)

One more influence of a water market on society that should be considered is the problem of a fall in land value due to the separation of land and water. The following example shows a case the CICL (Coleambally Irrigation Co-operative Limited) investigated on 25 September 2012.

- When 2000ha of land and a general security water entitlement of 1400ml were one, the value was A\$1.6 million. However, although the 1400ml of water is worth A\$1.1 million now, (A\$785 per ml), it is said that the 2000ha of land is worth about A\$300,000. As a result, the collateral value of land falls and it is said that it becomes impossible to take out sufficient loans and the tax

revenues from the local self-governing body's land is decreasing.

It is possible to separate water legally and institutionally from land so that security loans for water entitlements can be obtained and fixed taxation on excess property profits concerning water entitlement trading can be levied. In any event, it is not a problem that is impossible to cope with. (For example, it will also become important to decrease the issuing of superfluous water rights and to stabilise the value of water rights).

(3) Influence on the environment

A deterministic judgment cannot be made about whether the environment on the whole changed for the good in these 30 years. Byron describes this point as follows:

The Commonwealth will own some thousands of gegalitres of water entitlements. But it is still debatable whether the MDB ecosystems ... will be in much better condition than they were last year or 10, 20 or 50 years ago (Byron, 2011, p.386).

However, as Chapter 10 and Chapter 11 examined, many efforts for improvement are continued, such as:

- Increasing e-flow by a TLM (The Living Murray initiative) enterprise, basin plan, etc., and undertaking environmental regeneration enterprises,

- Producing fixed results in measures against damage from salinity,
- Produce mechanisms for providing water for the environment, such as CEWH, and use the water for environment,

As the damage caused by the superfluous use of river water or the influence of climate change is also aggravated, the judgment needs more examination over the long term. However, if activity of the CMA is also considered collectively, there is no evidence that the water market is participating in environmental aggravation at present but rather, as we showed in Chapter 10 and Chapter 11, it is thought that the environment and the water market have a symbiotic relationship.

In addition, there is the following interesting data about the environment: comparing the ratio of environmental-research expenditure to public research expenditure internationally.

	1995	2002	2005
AUS	1.2%	2.0%	4.2%
JPN	0.6%	0.8%	0.8%
USA	0.8%	0.6%	0.4%

Table 12.9: international comparison of public R&D budgets for the environment to total public R&D budgets

(Source: created from OECD, 2007, Environmental Data)

This shows Australia has put a big effort into environmental research. As Chapter 11 described, it is thought that practical use of water for the environment is a major factor that advances environmental research.

(4) Influence on the government sector

Next, we look at the influence of the water market on the government sector. The duty of self-support accounting management of water organisations was imposed by incorporation. Such an improvement would ease the governmental fiscal burden. Moreover, introduction of the water market would make the construction of huge dams unnecessary. Therefore, introducing a water market reduces government expenditure and is considered to contribute to the improvement in financial health. Table 12.10 looks at the ratio of the net debt of general government to GDP.

	1980	1990	2000	2010
AUS	-	9.6	7.1	4.4
JPN	16.8	13.2	59.6	112.8
USA	25.8	45.9	35.6	73.1

Table 12.10: general government net debt per GDP per cent

(Source: based on IMF, 2012, World Economic Outlook Database)

Although it is not quantitatively clear how much the introduction of a water market and public sector reform contributed to the numbers in Table 12.10, the Australian government finances are in a very healthy state – and the water reform and public sector reform of the 1990s are considered to have had a good influence on that.

As mentioned above, it is thought that the water market and the attendant water reform had good influence on the following points:

- expansion and increase in efficiency of agricultural output
- export expansion of agricultural products, and improvement in global competitiveness
- increase in the independence of farm management
- expansion in investment in environmental research
- improvement in the health of government finances.

Section 4: State government contributions: the meaning of the 2007 water reform

Australian water trading and the water market brought serious benefits to the economic, social and environmental fields. It can be said that it was achieved with the cooperation and determination of four key players: state governments, water corporations, CMA (and private sector entities) and MDBC/A. The preceding section, Section 4, Section 5 and Section 6

discuss and explain the factors and key players that brought about such success. First, in this section, we introduce water reform (the ‘unbundling process’) in Victoria in 2007 and afterwards (refer to Section 5 of Chapter 6 for the details).

‘Unbundling’ is separating the traditional water rights and licences in a fixed area into the following three:

- (1) water shares
- (2) delivery shares
- (3) water-use licences.²

The water rights in the regulated river in northern Victoria were divided on 1 July 2007. Although, of above three, water shares are separated from land, delivery shares and water-use licences are connected with land. Separation of land and water was finally attained by this ‘unbundling’.

Water share: these rights are accepted legally and are the secured share of water that can be used in a fixed basin system. Water share is defined as the maximum amount of the seasonal allocation water supplied to the share. There are two types of water shares: high reliability and low reliability. It is dependent on how much seasonal allocation water is actually distributed to each basin system. For example, in times of drought, the seasonal allocation of water may be 50 per cent. For those with

² When distinguishing seasonal allocations from water share, it can be said that it was divided into four by unbundling. Refer to Figure 6.4.

high reliability water shares of 100ml, for example, this means they can use 50ml of water in times of drought. Former water entitlements and diversion licences were converted into high reliability water shares. In northern Victoria, 20 per cent of new low reliability water shares have been given to the environment as a result of the agreement between farms and the government.

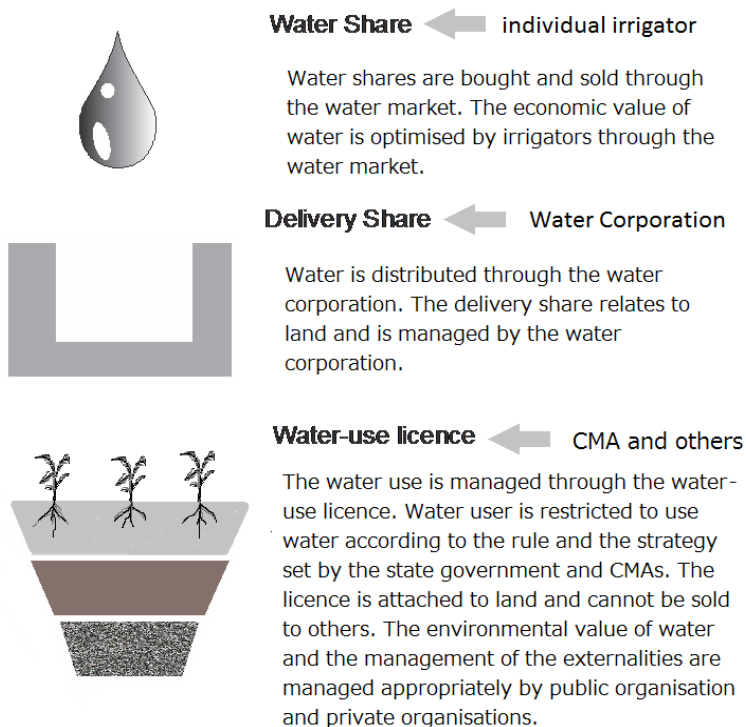


Figure 12.5: meaning of unbundling

(Source: created by author)

Delivery share: this right is to have water distributed to farmland of a certain irrigated land division. When the delivery

system is crowded, this right secures the share to the flow of water that can be used. Delivery share is connected with land and even when water shares have been dealt with outside a certain land division, they stop at the inside of a farm property. Irrigation farmers who do not need all or part of their delivery share after ‘unbundling’ will choose either

- (1) to continue payment for the delivery share in order to maintain the delivery infrastructure or to update the delivery share, or
- (2) to abandon part or all of their delivery share and pay the exit fee.

Water-use licences: these are the permission to use water for irrigation farms. The conditions previously applied to water use shift to a new permit in order that the change to the system does not affect the existing irrigation farms. A water-use licence specifies the permitted existing drainage method, including the AUL. It is connected with specific land and transfers with the land when land is sold.

The dissolution of such existing water rights can also take on the following meaning (refer to Fig.12.5). Water shares are clearly separated from land and the dealing of it is attained by free judgment of the economic unit in the water market. It can be said that it became possible to use water as a means of debt

or risk management and not only for mere economic good. It became clear that by separating the delivery share as an independent right, the independent management was made to bear the responsibility for and maintenance management of a water supply institution (water corporation). By connecting water-use licences to land, and setting up an organisation called CMA as an independent manager, frees the environment from the externalities (including salinity) that accompany water trading.

The **carry-over system** was also introduced in Victoria's water reform in 2007. Now a water share holder can choose to carry over to the following fiscal year some allocation water not be used or traded in the current year. Previously, unused allocation water was confiscated at the end of a fiscal year. Therefore, the carry-over system is useful also as a means of risk management by extending a limited opportunity for water supplies over many irrigation periods. Irrigation farms can have a carry-over of up to 50 per cent of their water share. However, the sum total of a carry-over and new allocation water is not supposed to exceed 100 per cent of the water share in any irrigation period.

Unbundling in Victoria was separate from the development of the water market and consideration for the environment and community, and had big influence when activating water trading.

The state government's Department of Water Resource recognised the subject in connection with water resources management in this way, and has solved it by law and regulation. In addition, state governments have played various roles, such as deciding on registration and accounting systems, zoning and trading rules. And it is clear that this led to development of the water market.

Section 5: Water industry reform and the creation of the internet market

The factors that developed the water market in Australia were a particular water distribution organisation and its management reform. Here we introduce the case of the northern Victorian Goulburn-Murray Water Corporation (G-MW) as a type of a water distribution organisation.

Although the irrigated land of the southern MDB was developed by the government and was settled and developed after World War II, public business organisations have borne the water supply services. Although there are 570,000ha of irrigation farmland in Victoria, for example, 500,000ha are the irrigation systems that were publicly developed. However, after fiscal bankruptcy occurred in the 1970s, followed by management reform in the 1980s, the public water supply organisation became a self-supporting accounting organisation.

It was incorporated in the 1990s as a self-support accounting organisation with a background of success in rebuilding the management into an efficient water company (refer to Chapter 7 for the details of the contents of this reform).

The existence of a stable water distribution organisation (measurement of water consumption included) is another premise of water trading. It is also important not only for it but also for irrigation farms to be conscious of the cost of water and the efficient utilisation of water. This consciousness can be increased by a relationship with a water company. Furthermore, in order to found a water market, fixed investment (human-resources development included) is required by a water supply organisation as well as management reform in order to advance in such a new field.

G-MW also participated in the establishment of direct relationships at the establishment of the Northern Victorian Water Exchange in 1998 and of the internet water market called Watermove in August 2002. (Watermove was closed in August 2012). The existence of such a water market contributed to the formation of a fair price, transfer of information and a reduction in transaction costs, and supported the development of the water market. And the fall of transaction costs led to the activation of a water market in which a majority of irrigation farms participate.

Section 6: Contribution of CMA and MDBC/A

Although the state government was responsible for water resources management and the environmental management of the river basin, when a water supply organisation with actual efficient management came into being, management of water resources was left to it. On the other hand, management of the environmental degradations and the ecosystem's integrity became the responsibility of public organisations called CMAs (**Catchment Management Authorities**), and the division of roles followed it. (CMA staff are government officials). CMAs are responsible for preserving the ecosystems, relieving damage from salinity and reserving water for the environment in line with the overall strategy for the whole state and the strategy of the MDBA. They form regional plans, raise funds and undertake required enterprises. However, because management of damage from salinity needs broad-based management that the state government cannot respond to itself, the executive responsibility moved to the MDBC/A (refer to Fig. 12.6 for the **dual management system** for water resources and the environment in Victoria).

In connection with water dealings, a CMA can affect the determination of required 'water use licences' when using water in a specific area. (Although the Minister for Water performs the determination itself, the CMA can give advice). Permission

cannot be given when diversion of a certain economic player worsens damage from salt water or specifically spoils an ecosystem. Furthermore, a water trading zone can be specified or a setup can be suggested for trading rules, such as a maximum amount of annual use of water (referred to as AUL) and a 4 per cent rule. These days, environmental reproduction is aimed at actually using the water for the environment that is supplied from the water market.

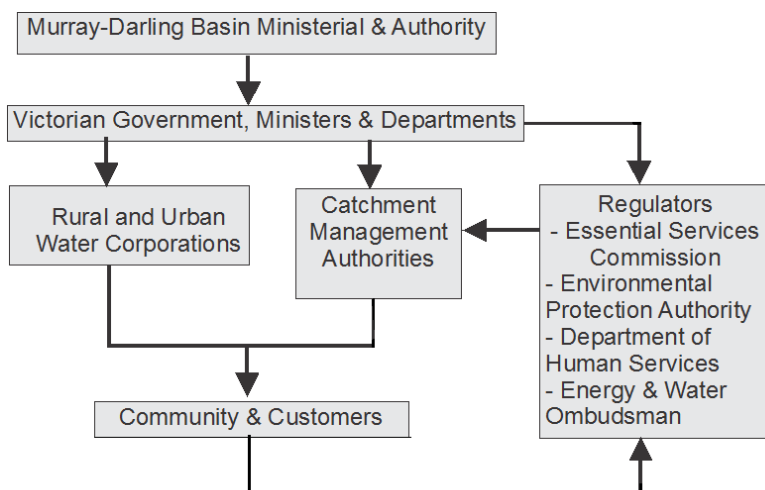


Figure 12.6: duplex system of water resources management and environmental management in Victoria

(Source: Victorian Government, 2008, Northern Region Sustainable Water Strategy; Discussion Paper, p.18)

For example, if a CMA performs an activity in connection with water trading, a setup of a trading zone and trading rules will follow.

A **trading zone** is an area in which most of the water share trading or allocation trading can be performed without restrictions. The southern MDB is an area where main rivers become intricately connected. The possibility of salinity generation is also high and the environment needs to be considered. So the zone in which it can be traded is specified and the trading of water shares and allocation water are enabled only between the specific zones. For more about the specification of the zones of the southern MDB, check the State of Victoria web pages.

An example of a '**trading rule**' is as follows.³

- The AUL is the annual maximum amount of water usable that is applied in the land specified in the water use permit or the water use registration document.
- The next restriction is imposed about shipment out of the area of water share. The 4 per cent rule pertains to the shipment of water share not being permitted when the net amount of the water left from an irrigated land region

³ For an explanation of a more detailed trading rule, refer to Water Trading Tool Kit, the Australian Government, 2009, p.15 or after.

exceeds 4 per cent of the total amount of water share of the area in one fiscal year. However, there is an exception. When the federal government purchased the water share up to 300gl over five years for the environment from 2008-09, the 4 per cent rule was not applied (Australian Government, 2009, p.16).

- In response to the concerns of irrigation farms, the Victoria government introduced the 10 per cent rule under which the size of the water rights people other than irrigation farms can own cannot exceed 10 per cent of the total amount of water share of the area.

Because a management system that is required to take measures against salinity damage crosses state borders, the **MDBA** and **CMAs** of the area cooperate and perform broad-based management. The area predicted to be aggravated by salt water damage in 2050 is shown in Figure 12.7. The **MDBA** is going to cooperate with the relevant **CMA** of each state and cope with this problem by using the salinity register and Basin Salinity Management Strategy (refer to Chapter 10 for details).

The Basin Salinity Management Strategy (BSMS) is a guideline for communities and the government on how to cooperate in managing the damage from salt water in the **MDB**

and holding each drainage basin and its natural assets. It sets up the river salt concentration (management desired value) of the MDB in every main region and determines this under the joint liability organisation of the region's residents and each state. It is presumed that a desired value will be set to the exit point of each region. The Morgan point (see 10.3.2) of SA was set by the MDBC council in a plan for 15 years and the electrical conductivity (EC) is specifically maintained at or less than 800 in 95 per cent of the setting period at the Morgan point as a target for the whole MDB.

The MDBC also introduced a salt registration system. This attempts to evaluate how much the salt concentration of a river is increased or decreased (as a 'salt credit' or a 'salt debt') on average in projects that affect the salt concentration of a river, and to manage them by an account form.

Acts counted as a salt credit (+) would, for example, be enterprises that intercept the outflow of salt and trades that lead to a withdrawal of irrigation and a dilution of the delivery of water downstream.

Acts deemed as a salt debt (–) would, for example, be building drainage canals for irrigation, construction of pumps for groundwater, new development of irrigation farmland and a rapid water supply (wetland flushing) to a damp area.

Change and construction of a management policy that affects the salt concentration of a river is also recorded on a salt registration system (refer to Section 3 of Chapter 10 or NWC, 2010a, Appendix G for details).

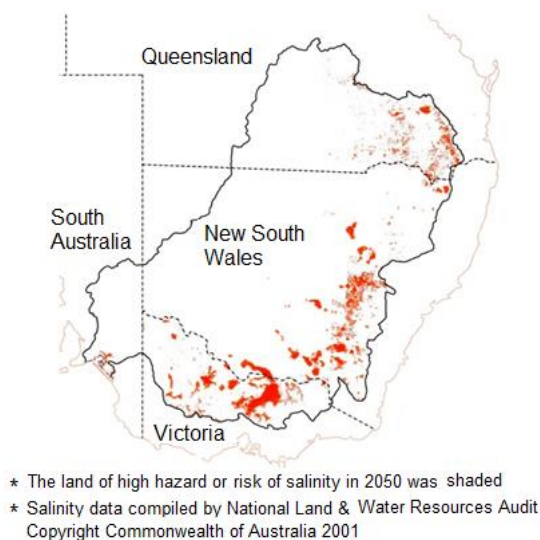


Figure 12.7: salinity damage prediction in 2050

(Source: http://www2.mdbc.gov.au/__data/page/104/prelims.pdf, partly modified)

Table 12.11 shows the result of the 2003-4 salt register system managed by the MDBA.

SUMMARY-COMMISSION REGISTER A	NSW	Vic	SA	Qld	Total
Credits and Debits from Joint Schemes	14.8	14.8	0	0	29.5
Credits and Debits from State Actions	-8.5	-4.8	5.1	-	-8.2
Balance-Register A	6.2	10.0	5.1	0	21.3

SUMMARY-COMMISSION REGISTER B	NSW	Vic	SA	Qld	Total
Credits and Debits from Joint Schemes	-	-	-	-	-
Credits and Debits from Delayed Salinity Impacts	-3.8	-4.1	-8.6	-0.3	-16.7
Balance-Register B	-3.8	-4.1	-8.6	-0.3	-16.7
Balance-Register A and B	2.5	5.9	-3.6	-0.3	4.6

Table 12.11: summary of commission registers A and B (currently transitional) for 2003–04 (salinity credits and debits-equivalent EC)

(Source: http://www2.mdbc.gov.au/_data/page/899/Executive_Summary.pdf)

According to Table 12.11, under the influence of the past actions, the salt debts of -8.6 in SA, -4.1 in Victoria, -3.8 in NSW and -0.3 in Queensland can be observed. However, as a result of independent action or tackling the measures against salinity together, the salinity credits were made to increase by 10.0 in Victoria, by 6.2 in NSW, and by 5.1 in SA as a net value, and the salt credit for 2003-04 improved by only 4.6 as a result.

Similarly, the salinity credit balance of 2008 arising from trade-related actions is as follows. With reference to salinity damage at the Morgan point in SA, new irrigation developments within each state in the Mallee cause annual increase in average river salinity within the range of 1.8-11.9 EC. However, after measures against salinity were implemented the salt registration

in November 2008 showed all the credits for NSW, Victoria and SA had a net increase value, showing that salinity measures have been improved as a whole (NWC, 2010a, p.223).

As a result of such measures (the system and strategy for managing externalities, such as BSMS and water use licence systems), the NWC estimates it succeeded in eventually offsetting the impact of the salt accompanying water trading.

Thus, the management of water as an economic good and the management of it as an environmental good are undertaken by separate special organisations with state governments responsible for overall integrative management. The MDBA manages salt water damage in association with the MDB. With organisations based close to the relevant environments and with residents having substantial decision-making power, it is thought that citizen participation in Australia's multi-tiered municipal-type environmental management systems is functioning well.

Section 7: Lessons and features of the Australia model

Australia has about 30 years' history of water trading. It functions with the cooperation of four key players: state governments, water corporations, CMA (and private sector entity) and MDBC/A, and helped by cooperation from the federal government and residents.

What should we learn from such an experience?

The first is the unbundling process. Water rights were initially a usufructuary right attached to land. Then water rights were legally accepted as a right of private property in 1989, and in Victoria in 2007 and afterwards it was further unbundled into three: water shares, delivery shares and water use licences. These three areas attain maximisation of water's economic benefit and it is thought that this unbundling greatly contributed to the minimisation of the negative influence on the environment (or maximising environmental value).

The second is the management reform (corporatisation) of the water supply system. In the MDB, it was difficult to overcome the existence of irrigation agriculture by individual enterprises and it needed power of public participation through large-scale dam development, the construction of water-use facilities and the management of water. The government created the large-scale infrastructure required for irrigation agriculture. Although in the beginning publicly managed organisations had managed large-scale water-use facilities, many states were hit by the financial crisis in the 1970s. This increased the necessity for more efficient management and consequently the second half of 1980s and the first half of 1990s saw the introduction of management reforms such as corporatisation and the reform of the water price. This included a thorough reexamination of

business, increased efficiency, the introduction of IT, personnel reduction and the installation of measuring instruments. This resulted in a growing public awareness of the concept of a ‘cost for water’.

Simultaneously, water supply organisations became directly responsible for the creation and development of a water market. Farms’ awareness of water costs also increased due to the rise of the water price; and there was stability within the management of the water supply organisation. Water auctions especially recognised the cost of water – and it was a historically significant landmark when the price of water was first published on 4 May 1988 at an average of A\$239/ml. Not only did awareness of the cost of water increase, but the arrangements were advanced for unused water rights for low interest (called ‘dead water rights’ and ‘sleeping water rights’). And while the introduction of the Cap systems discussed later is not a premise of water market development, they should not be overlooked.

The third is construction of multi-level and citizens’ participation in integrated catchment management through the local government system. The subsystem that manages externalities, economic efficiency and risk management is well constructed for in multi-level participation. For example:

- The MDBC/A takes measures against salinity damage and the interstate trading of water rights.

- The federal government manages water for the environment.
- The state government and CMAs (and private sector entities) take care of environmental preservation of the area.
- The water market ensures efficient economic utilisation of water.

Although residents, the federal and state governments, CMAs and the water market become entangled organically and give priority to their own interests within such a subsystem, on the whole it has created a democratic and efficient integrated system of governance for water resources. It can be said that the introduction of this system has led to a symbiotic relationship between the water market and the environment.

The fourth is the introduction of Cap and prolonged drought. Although the introduction of the Cap system and prolonged drought were a crisis for the water suppliers and led to stringent water supply restrictions, the water market came to be seen as a means to overcome the crisis, and the crisis also became a starting point for the development of water trading and the market. While the introduction of the Cap system urged management reform of the water supply organisation, it also promoted arrangement of the above-mentioned 'dead water

rights' and 'sleeping water rights' and formed the foundation for the development of water rights trading.

The fifth is unitary management of the water resources administration and the stewardship or leadership by state governments. Water resources management is the authority of state governments and the state governments in Australia had an organisation (ring-fence system) that managed all water across the board. This is influenced historically by the federal system. The state governments played an important role in having built the organisations that managed water and then guiding the reform connected to various water resources.

The sixth is the federal government's support and the involvement of the MDBC/A through various water reforms such as Cap, COAG, the proposal of NWI, BSMS and TLM. For example, the creation of the water market used the subsidy called 'tranche payments' and federal government guidance on corporatisation reform. Reform of the MDBC/A cleared the way for integrative catchment management and played an important leadership role when completing the symbiotic relationship between the environment in the MDB (especially, salinity) and the water market.

The seventh is the originality, creativity and tenacity of the Australian people (irrigation farmers included) who overcame the conflict between the environment and the economy and

created a system called a water market and helped it evolve into a sustainable system in spite of the external factors of the Cap system or drought. While conquering various external crises, water trading and market, integrative catchment management and risk management were qualitatively strengthened and the water market has evolved into a robust system in which many people dynamically participate.

We will summarise and generalise the factors of the development of the Australian water market as follows:

- (1) The unitary management system of the water resources by state governments and the efficient water supply organisations (water corporations) existed independently under a decentralised system called the federal system.
- (2) The water distribution organisation has been corporatised through management reform and organisations have been created that support a water market by stabilising and restructuring management and people's cost consciousness regarding water and irrigation farm management has been changed.
- (3) Farms replaced their method of gaining water mainly through a water market brought about by the introduction of the Cap system and the prolonged drought. Well adapted for such a change, it tackled positively the need

for an increase in efficiency and improved management of water use, and was ready for utilising a water market.

- (4) Governments, the MDBCA and scientists presented clearly the need for various reforms (i.e. practical use of a market system and micro-economic reforms for international competition) centring on the foundation of a water market in such a situation. Governments and people were united and tenacious efforts for reform were continued.
- (5) They succeeded in building a flexible system that can optimise the many-sided value of water without being mutually contradictory, especially by the unbundling of water rights and the construction of multi-level and citizens' participation through the local government system for integrated catchment management.

The features are efficiency, low transaction costs, a symbiotic relationship, sustainability and the cooperation of administration and residents. Stated directly, the Australia model, which succeeded in changing the relationship between the economy and the environment into a symbiotic one, will be regarded as an example of successful cooperation between administration and residents.

Chapter 13

Estimation of the Economic Surplus in a Water Market: the case of northern Victoria, Australia

Section 1: Introduction

Water markets have existed in Australia for about 30 years and are growing in both a qualitative and quantitative sense (the National Water Commission [NWC], 2011b). In June, 2010, the NWC published its assessment of the economic, social and environmental impacts of water trading and concluded that water trading has significantly benefited individuals and communities across the southern Murray-Darling Basin (NWC, 2010a, p.v). In Australia today, the economic impacts of water trading are gaining more attention.

The NWC uses a CGE model to estimate the macro-economic effect of water trading.¹ This model compared two cases, one *with* the water market and one *without* the water market and used a model with based on the following assumptions to calculate how much the reduction of production levels by a drought could be stopped:

¹ Refer to NWC, 2010a, Appendix C for the details of a CGE model.

“The modelling estimated that water trading in the sMDB increased Australia’s gross domestic product by more than A\$ 220 million in 2008-09. The total benefits were even greater within the sMDB, where water trading increased gross regional product by over A\$ 370 million in that year ...” (NWC, 2010a, p.84).

We will call analysis using this model an ‘objective valuation’ method and will call the result a ‘ratchet effect’. Although we would like to applaud this as the one of the first analyses to delve deeply into the comprehensive economic effect of the water market of Australia, it does not consider in its evaluation the subjective degree of satisfaction of irrigation farmers who participated in the water market.

Thus, we need a new approach. We must assess the economic contribution of the water market as perceived by the participants. When performing an overall assessment of the economic contribution of a water market to a society as a whole, the ‘subjective valuation’ of such participants is an important element that cannot be ignored.

However, there is minimal research literature available about the economic surplus analysis of a water market. Although there has been some research into a water demand function, little what is being studied considers the connection to an economic surplus (Wiljdasa *et al.*, 2002, Latinopoulos, 2004, Bontemps and Couture, 2001, Kenney *et al.*, 2008). Even when the economic

surplus is calculated, there is almost no measurement of the water demand function of the market at that time. Thus we have to develop a method for measuring the economic surplus in a water market.

Section 2: Model and methodology

13.2.1: Model

The expected price of certain joint products is set to q and the amount of water injections per ha is set to w for joint products. The parameter showing the situation of precipitation, such as a drought, is set to μ . And the joint production in that case is written as $f(w, \mu)$. f is a production function showing the relation between the amount of water injected and the production quantity of a joint product. When the quantity of production needs to be distinguished for every producer, it is distinguished by subscript i or j . Although μ is a parameter showing the situation during a drought, it is taken as the probability of allocation water over the water entitlements generally released at the start time of an irrigation season. ($0 \leq \mu \leq 1$).

On the other hand, for production, the expense C is required and the cost function is considered by dividing into two parts. The first expense is the one relevant to the productive consumption of water (and land), for example, the cost of

energy, fertiliser and seed, plus the expense of increased employment, etc., and is written as $C(w, \mu)$. The second is the expense (or income when selling) when purchasing water from a water market, and this can be written as $p^0 \cdot (w - \mu \cdot \bar{w})$. Here, p^0 is an average expected price of the water market over the whole irrigation season, and \bar{w} is the amount of water entitlements on the title which this irrigation farmer holds. If carried out, this irrigation farmer's profit maximisation action can be described as follows:

$$\text{Max } \pi = q \cdot f(w, \mu) - C(w, \mu) - p^0 \cdot (w - \mu \cdot \bar{w}) .$$

If μ is constant, $q \cdot f'(w^0) - C'(w^0) = p^0$ expresses the necessary condition for profit maximisation, but it is possible to decide the annual water consumption w^0 per ha of land and the maximum demand volume of profit $\pi^0 = q \cdot f(w^0) - C(w^0) - p^0 \cdot (w^0 - \mu \cdot \bar{w})$. Similarly, the purchase amount of water (or sales amount of water) w from the water market of this irrigation farmer is decided as $w = w^0 - \mu \cdot \bar{w}$. (In the case of $\mu \cdot \bar{w} < w^0$, he becomes a buyer of water in a water market, and, in $0 \leq w^0 \leq \mu \cdot \bar{w}$, he becomes a seller of water).

I will define NE , ANE , and MNE as follows for next facilities:

$$NE = NE(w) = q \cdot f(w) - C(w)$$

$$ANE = ANE(w) = NR(w) / w = \{q \cdot f(w) - C(w)\} / w$$

$$MNE = MNE(w) = dNR(w)/dw = d\{q \cdot f(w) - C(w)\} / dw = q \cdot f'(w) - C'(w)$$

and will call this a net earnings, an average net earnings, and a marginal net earnings, respectively. Then, at the point of maximum profit, since it is set to $MNE(w^0) = p^0$, it turns out that $w^0 = MNE^{-1}(p^0) = D(p^0)$, i.e. a water demand function, is the inverse function of a marginal net earnings function. Moreover, $\pi^0 = w^0 \cdot ANE(w^0) - p^0 \cdot (w^0 - \mu \cdot \bar{w})$ is realised (refer to the equation 16 of Chapter 3).

Next, the number of decisions made about the water purchase (or sale) in a certain irrigation season is set to T , and the water market price anticipation at each decision-making time is set to p_t , the amount of water purchase (or sales) is set to w_t ($t=0, 1, \dots, T$). $\{\lambda_t\}$ ($t=0, \dots, T$; $\sum \lambda_t = 1$) shows time distribution of w_t and it is assumed beforehand that the distribution was decided by the characteristic of crops. That is, $w_t = \lambda_t \cdot (w^0 - \mu \cdot \bar{w})$, $t=0, \dots, T$, is realised.

If this irrigation farmer is going to secure the profits of π^0 , the following equation of relations need to be realised:

$$\sum_{t=0}^T \{(p_t - \bar{p}) \cdot \lambda_t\} = \bar{p} - p^0 \quad (1)$$

$$\text{Here, } \sum_{t=0}^T w_t = w^0 - \mu \cdot \bar{w}$$

$$w_t = \lambda_t \cdot (w^0 - \mu \cdot \bar{w}) \quad (2)$$

$$\bar{p} = ANR(w^0).$$

Because, it is if it multiplies by $w^0 - \mu \cdot \bar{w}$ both sides of equation (1) and $\bar{p} \cdot \mu \cdot \bar{w}$ is added, it changes to

$$\begin{aligned} & \bar{p} \cdot \mu \cdot \bar{w} + \sum_{t=0}^T \{(p_t - \bar{p}) \cdot w_t\} \\ &= \bar{p} \cdot \mu \cdot \bar{w} + (\bar{p} - p^0) \cdot (w^0 - \mu \cdot \bar{w}) \\ &= \bar{p} \cdot w^0 - p^0 \cdot (w^0 - \mu \cdot \bar{w}) \\ &= w^0 \cdot ANR(w^0) - p^0 \cdot (w^0 - \mu \cdot \bar{w}) = \pi^0. \end{aligned}$$

Therefore, as long as the sequence of $\{p_t\}$ follows the (1) and (2), the maximum volume of profit planned at the beginning can be gained. An example of $\{p_t\}$, $t=0, \dots, T$, was shown in Figure 13.1.

The point to be careful of is that the sequence of $\{p_t\}$ exists innumerable. Moreover, although the levels of p_t are scattered all over the surroundings of \bar{p} , they do not have a direct relationship with the level of the marginal net earnings $MNE(w)$. And as long as it is for the purpose of preserving the maximum profits planned by the irrigation farmer at the beginning, it is thought that $\{p_t\}$ has given the base price in the case of purchasing (or sale) water in a water market. In other words,

$\{p_t\}$ is a true subjective price sequence required in order to calculate an economic surplus.

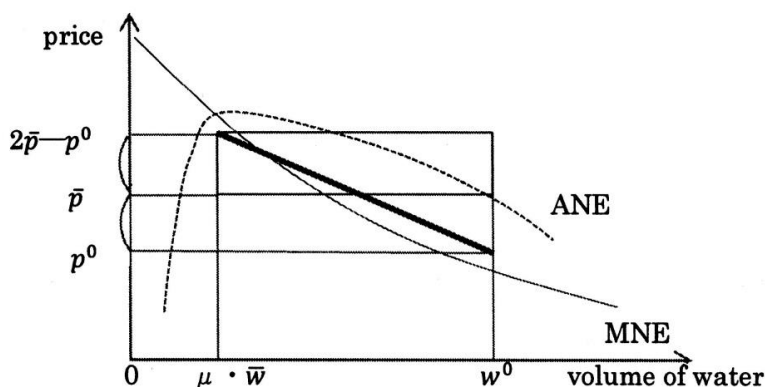


Figure 13.1: example of $\{p_t\}$ in a buyer's case

Based on the argument of $\{p_t\}$ on the above, if the market price realised in the actual water market is made into p_t^* and realised trading volume is made in to w_t , this producer's true seller's surplus and buyer's surplus will be calculated as follows:

True surplus of buyer i at time t :

$$(p_{it} - p_t^*) \cdot w_{it} \quad \text{for } p_{it} > p_t^*$$

True surplus of seller j at time t :

$$(p_t^* - p_{jt}) \cdot w_{jt} \quad \text{for } 0 < p_{jt} < p_t^*.$$

} ----- (3)

It should be noticed that if it holds $p_t < p_t^*$ in a buyer's case and $p_t > p_t^*$ in a seller's case, economic surplus is not produced respectively. It is because the water trading itself is not materialised in each case. Therefore, even if he would like to buy it with p_t as a buyer, as long as it is expected that a market price holds $p_t < p_t^*$, there is a high risk of these dealings going wrong. In this case, by making α (>0) into a strategy factor, and a buyer achieves successful dealings, he may correct the buying order price at time t up so that it may become $p_t + \alpha > p_t^*$. (A seller can argue similarly). That is, generally it may differ from p_t and show the actual market price. Next we discuss this problem in detail.

13.2.2: Water demand function in water market on each occasion

It became clear in the previous argument that there are two kinds of water demand function. One is the inverse function of MNE , and when a water price (expected average price of the whole irrigation season: p^0) is given, it specifies the water a producer needs over a whole season. The second is a water demand function needed in the water market each time the market price of water is determined. Although there has been some research into the former, little has so far been done into the latter. In this section, the second meaning of the water demand function is discussed.

As discussed in 13.2.1, if the expected average water price p^0 of whole season, the water distribution $\{\lambda_t\}$ of a certain crop and the situation parameter μ of a drought are given, it is possible to determine the sequence of the water amount demanded (or supplied) in the water market at each time $\{w_t\}$ and a true demand price sequence (or true supply price sequence) $\{p_t\}$. Below, in order to distinguish a buyer and a seller, subscript 'd' or 's' will be given to a variable. To distinguish the true price explained by 13.2.1, and the presented price (ordered price) in the actual water market including the strategic factors, the subscript of 'e' will be given to the former. And supposing buyers are n person and sellers are m person, the true order set at each time is described as follows:

$$\begin{array}{l}
 \text{Buyers' true order set at time } t \\
 = \{(pd_{1t}^e, w_{1t}^d), (pd_{2t}^e, w_{2t}^d), \dots, (pd_{nt}^e, w_{nt}^d)\} \\
 \text{Sellers's true order set at time } t \\
 = \{(ps_{1t}^e, w_{1t}^s), (ps_{2t}^e, w_{2t}^s), \dots, (ps_{mt}^e, w_{mt}^s)\}
 \end{array}
 \left. \vphantom{\begin{array}{l} \text{Buyers' true order set at time } t \\ \text{Sellers's true order set at time } t \end{array}} \right\} \text{----- (4)}$$

Here, a true order set of buyers is arranged in descending order from the highest price, and a true order set of sellers assumes is arranged from the cheapest price in ascending order. The true order of the same price will be added together (see Chapter 5 and Appendix to this chapter).

Next, the cumulative demand function CD and the cumulative supply function CS are defined as follows (suffix t is omitted).

$$\left. \begin{aligned} x_i^d &= \text{CD}(pd_i^s), x_i^d = w_1^d + w_2^d + \dots w_i^d, i=1,2,\dots,n \\ x_j^s &= \text{CS}(ps_j^s), x_j^s = w_1^s + w_2^s + \dots w_j^s, j=1,2,\dots,m \end{aligned} \right\} \text{----- (5)}$$

For example, when the trading volume's distribution of a true order set is a normal distribution about a price, each cumulative curve (i.e. CDC and CSC) will become as shown in Figure 13.2 (refer to Figure 5.2 of Chapter 5). In the case of uniform distribution, it becomes linear.

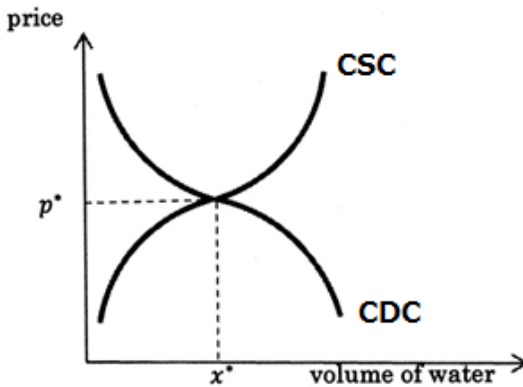


Figure 13.2: example of CSC and CDC

Therefore, the market equilibrium price (p^*) at time t can be decided as $\text{CD}(p^*) = \text{CS}(p^*)$ is realised. Here, $\text{CD}(p^*)$ in this case is a water demand function at the time t of a water market. So, in order to calculate the buyer and seller surplus at each

transaction, we have to presume CD curve (CDC) and CS curve (CSC) on each occasion. Furthermore, it is thought that distribution of the average net earnings of irrigation farmers have had big influence on the form of CDC or CSC.

13.2.3: Direct method

Supposing that the prices (ordered prices) that were shown in the actual water market were exactly the same as true prices, that is, $ps_i^e = ps_i$ and $pd_j^e = pd_j$, an economic surplus is easily calculable. It can be shown as follows when it calculated using an example² (refer to Table 1).

Seller's surplus				Buyer's surplus			
No.	price	volume	seller's urplus	No.	price	volume	buyer's surplus
S1	80	20	1400†	B1	250	10	1000
S2	100	30	1500	B2	200	20	1000
S3	150	30	0	B3	180	30	900
				B4	150	20	0
Seller's surplus in total			2900	Buyer's surplus in total			2900

Table 13.1: example of surplus calculation (direct method: unit A\$)

(† In this example, the equilibrium price (p^*) is 80.

The seller's surplus of number s1 is set to $1400 = (150 - 80) \times 20$.

Hereafter, it is calculable similarly)

² The measurement result of the northern Victoria by direct method was calculated with 11.8% of the amount of money for dealings in the seller surplus, and the buyer surplus was calculated with 10.4%.

Theoretically there should be a price expressed in the market equal to marginal net earnings (*MNE*) or the cost asked for purchasing the substitute of the input goods replaced with water.³ However, this is applied through the whole irrigation season, and, because of the existence of strategic factors, the actual market price does not necessarily directly correlate with marginal net earnings and an asking price (see Figure 13.1). For example, in the whole of 2009-10, the dealing strike (or successful) rate (=the number of the seller's orders with dealings realised / total number of the seller's orders) of the participants of our target area (zone 1A), was 38.2 per cent for the seller and 51.8 per cent for the buyer. For a seller to make a successful sale from such a low strike rate, he has to set a price less than the equilibrium price expected. Similarly, it is advantageous for a buyer to set a price that is more than the equilibrium price. For this reason, calculation of the economic surplus by the direct method may give the wrong information about the true price of a water market.

The second problem with the direct method is that, no matter what price a market equilibrium price may reach, the negative economical surplus of the participants who succeeded in market dealings is not produced. 13.5.2 discusses the negative surplus.

³ For example, in the case of dairy farmer, at water prices higher than A\$300/ml, they can reduce water purchases and increase fodder purchase to substitute for reduced on-farm pasture production. Refer to NWC, 2010a, p.26.

We propose the use of the Contingent Valuation Method (CVM)-Trigonometric method instead of this direct method.⁴

13.2.4: CVM-Trigonometric method

An outline of the CVM-Trigonometric method is as follows. Suppose that the size of the marginal net earnings (MNE) (or expected price) of a seller and a buyer was revealed by the questionnaire.⁵ The results of the questionnaire are divided into a seller and a buyer. However, for the sake of brevity, we will explain the case of the seller.

The expected price data which exceeds the market equilibrium price at each time is removed. The sample price set of the seller who succeeded in dealings is set to $\{ps_1^e, ps_2^e \dots, ps_k^e\}$. In this case the sellers' prices are arranged in ascending order. (In the case of the buyer, buyer's prices are arranged in descending order). And k is the number of sellers

⁴ Although dichotomous choice approach based on random utility theory was dominant about the CVM analysis in recent years, our method was utilised directly and asked the amount of willingness to pay (WTP) by open-ended method. This method is effective when a virtual market has the familiarity for a respondent. About the utilising method and problem of the CVM, refer to Mitchell and Carson, 1989, Hanemann, 1995, Hanneman, 1984, etc. About the actual example of application, refer to Liu & Kondo, 2008, Mwebaze and Bennett and 2012 etc.

⁵ Our key questions in the case of allocation trading market are as follows: To a seller: "If you sold temporary water, please let me know the minimum acceptable price of each month that you were prepared to receive.", To a buyer: "If you bought temporary water, please let me know the maximum acceptable price of each month that you were prepared to pay."

who presented the expected price below a market equilibrium price. ($k \leq m$).

Total seller's economic surplus at each time (SS) serves as follows by (3):

$$\begin{aligned} \text{SS} = & (p^* - ps_1^e) \cdot w_1^s + (p^* - ps_1^e) \cdot w_2^s + \dots \\ & + (p^* - ps_{k-1}^e) \cdot w_{k-1}^s + (p^* - ps_k^e) \cdot w_k^s \end{aligned}$$

If cautious of ps_k^e being the same as p^* , the last term of an upper equation will serve as zero. Here, p^* is a market equilibrium price at each time and w_k^s is the trading volume of seller k .

If it is written as $x_1 = w_1^s, x_2 = w_1^s + w_2^s, \dots, x_k = w_1^s + w_2^s + \dots + w_k^s$, and $x^* = \sum_{i=1}^k w_i^s$, SS will become

$$\begin{aligned} \text{SS} = & \{(p^* - ps_{k-1}^e) + (ps_{k-1}^e - ps_{k-2}^e) + (ps_{k-2}^e - ps_{k-3}^e) + \\ & \dots + (ps_2^e - ps_1^e)\} \cdot w_1^s \\ & + \{(p^* - ps_{k-1}^e) + (ps_{k-1}^e - ps_{k-2}^e) + (ps_{k-2}^e - ps_{k-3}^e) + \\ & \dots + (ps_3^e - ps_2^e)\} \cdot w_2^s \\ & + \{(p^* - ps_{k-1}^e) + (ps_{k-1}^e - ps_{k-2}^e) + (ps_{k-2}^e - ps_{k-3}^e) + \\ & \dots + (ps_4^e - ps_3^e)\} \cdot w_3^s \\ & \dots \\ & + \{(p^* - ps_{k-1}^e)\} \cdot w_{k-1}^s \\ = & (p^* - ps_{k-1}^e) \cdot x_{k-1} + (ps_{k-1}^e - ps_{k-2}^e) \cdot x_{k-2} + \dots \\ & + (ps_2^e - ps_1^e) \cdot x_1 \end{aligned}$$

$$\begin{aligned}
&= x^* \cdot \{ (p^* - ps_{k-1}^e) \cdot (\xi_{k-1} + \xi_{k-2} + \dots + \xi_1) \\
&+ (ps_{k-1}^e - ps_{k-2}^e) \cdot (\xi_{k-2} + \dots + \xi_1) + \dots + (ps_2^e - ps_1^e) \cdot \xi_1 \} \\
&= x^* \cdot \{ p^* \cdot (1 - \xi_k) - \sum_{i=1}^{k-1} ps_i^e \cdot \xi_i \} \\
&= x^* \cdot (p^* - \sum_{i=1}^k ps_i^e \cdot \xi_i),
\end{aligned}$$

Where $\xi_i = w_i^s / x^*$, $i = 1, 2, \dots, k$.

Since $\sum_{i=1}^k ps_i^e \cdot \xi_i$ means the weighted average of seller's expected prices (or average net earnings), we write this as ps_A^e .

Therefore, it becomes

$$SS = x^* \cdot (p^* - ps_A^e). \text{-----} (6)$$

After collecting the information about an expected price, there arises the important problem of how to collect the information about the distribution $\{\xi_i\}$ ($i = 1, \dots, k$) of trading volume at each transaction. We propose replacing the trading volume w_i^s in each market and using the maximum annual allocation amount of water y_i as the proxy variable of w_i^s for the following reasons:

As trading volume varies greatly in the short-term and, usually, considerable time passes after the actual dealing, it is difficult to grasp the exact trading volume distribution from the questionnaire at each market. (On the other hand, the maximum annual allocation amount of water based on water entitlements and land ownership does not change in the short run).

It is thought that a long-term water demand structure has specified an approximate short-term water demand structure (see Appendix Table 13.3 for details).

Furthermore, it calculates this SS as an area which consists of a market equilibrium point (p^*, x^*) , an equilibrium price point $(p^*, 0)$, and a Zs point $(ps_Z^e, 0)$. This is equal to approximating a Cumulative Supply Curve (CSC); $\{(ps_i, x_i)\}$ as a straight line which passes along Zs point and a market equilibrium point (refer to Figure 13.3). Estimation of ps_Z^e will give the information about a CSC curve (and a CDC curve) at each market. Furthermore, ps_Z^e can be considered to be the seller's minimum expected price (or minimum average net earnings).

By definition of Zs point, we obtain

$$SS = (p^* - ps_Z^e) \cdot x^* / 2. \text{-----}(7)$$

Then, from (6) and (7),

$$ps_A^e = (ps_Z^e + p^*) / 2 \text{-----}(8)$$

is obtained. Therefore, ps_A^e can be understood as the middle point of ps_Z^e and p^* .

In Figure 13.3, p^* is the market equilibrium price. ps_{min} is the minimum seller's offer price observed in the actual market, that is $ps_{min} = ps_1$. Similarly pd_{max} is the maximum buyer's offer price observed in the actual market, that is $pd_{max} = pd_1$.

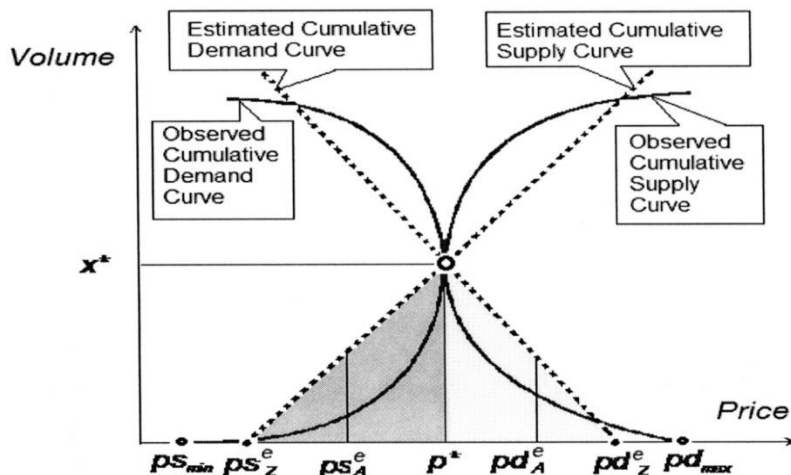


Figure 13.3: illustrated CVM-Trigonometric method

Note: $ps_{min} = \min\{(ps_i)\}$, $pd_{max} = \max\{(pd_j)\}$

The procedure of our CVM-Trigonometric method is as follows (in the case of a seller):

(Step 1) The expected price data (ps_i^e) at each time and the maximum annual allocation amount of water data (y_i) are provided by a questionnaire.

(Step 2) The data about a market equilibrium price (p^*) and trading volume (x^*) is obtained from the Victorian water register or water market brokers.

(Step 3) Calculate $ps_A^e \doteq \sum ps_i^e \cdot (y_i / \sum y_i)$ except for the data exceeding the market price at each time of an expected price.

(Step 4) Calculate the seller surplus (SS) and minimum average net earnings (ps_z^s) at each time (refer to appendix to Chapter 13 for detail).

Section 3: An application in northern Victoria, Australia

13.3.1: Target area

The principal water systems and trading zones of the southern Murray-Darling Basin (sMDB) are written in NWC report (NWC, 2010b, Figure 2.5, p.21). The sMDB is not only a centre of irrigated agriculture in Australia, but a central water market. The sMDB consists of portions of three states – NSW, Victoria and SA – and the whole area of the ACT.

Our target area is northern Victoria, an area of 68,000 square kilometres located inside the sMDB which acts as one of the main water markets in Australia. There are about 1.5 million hectares (15,000 square kilometres) of irrigated land in northern Victoria, in the area surrounding the Murray River between Mildura and Cobram.

The basin system and irrigation water in the area had been managed by Goulburn-Murray Water (G-MW). Although 15 trading zones are set up in the area, the Greater Goulburn area (including zone numbers 1A, 1B and 1L) serves as the centre of price formation in Victoria (refer to Figure 6.8 for the details of trading zones).

13.3.2: The outline for the investigation

The investigation period covered an irrigation season from August 2009 to May 2010, a year of recovery from a long drought. The questionnaire survey was carried out from September to December 2010 through the cooperation of three farming organisations: Fruit Growers Victoria (FGV), Victorian Farmers Federation (VFF) and United Dairy Farmers (UDF). Because this was not a perfect random sampling, a responses may show some deviation. The questionnaire was distributed to 1000 households involved in irrigation farming. There were 114 completed surveys that were received (112 effective replies). Types of farms receiving the questionnaire were as follows (refer to Table 13.2):

Dairy farm	Horticulture		Mixed farm, Cropping farm and Others	Unknown	Total
	Annual	Perennial			
84	7	11	7	3	112
75.0%	6.3%	9.8%	6.3%	2.7%	100%

Table 13.2: distribution of respondents' farm type

The ratio of total responses compared to the G-MW operating area was as follows (refer to Table 13.3):

	Volume managed or owned (ML)	Volume allocated in 2009-10 (ML)
G-MW(A) †	2,011,195	1,510,892
Respondent total(B)	86,191	33,090
Ratio (A/B) (%)	4.3%	2.2%

Table 13.3: ratio of respondents to the G-MW operating area

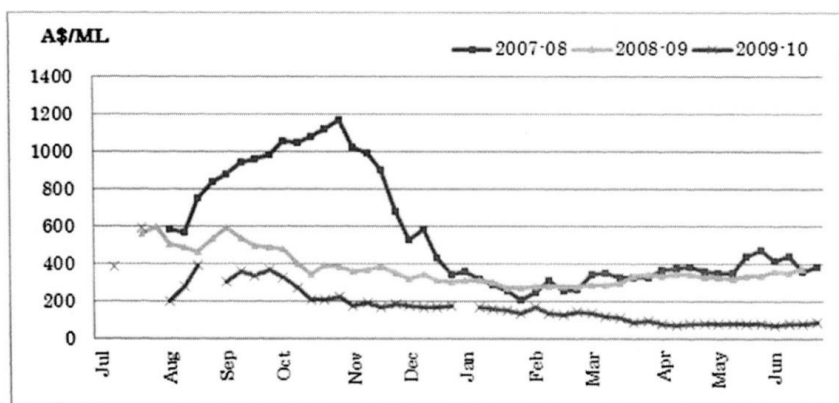
(† data concerning G-MW is obtained
from NWC, 2010b, p.19, and p.87)

13.3.3: Outline of water market in Australia

Australia has two kinds of water trading. These are called ‘entitlement’ trading (previously referred to as ‘permanent’ trading) and ‘allocation’ trading (previously referred to as ‘temporary’ trading). Entitlement trading is not only the movement of water, but also the transfer of a private property’s right to the water. Allocation trading does not transfer a private property’s right to water, but only the right to use the water. Although there were centres trading before, only recently did entitlement trading come to be conducted briskly in dollar terms. The turnover of the Australian water market was about A\$3billion in the 2009-10 fiscal year – a scale thought to be the largest in the world (NWC, 2010b, Table 3.5, p.34; see also Section 5 of Chapter 1).

Shown below is the trend of the average price of allocations

for the past three years in the sMDB (refer to Figure 13.4). The pondage of dams in 2007-08 was 18 per cent, in 2008-09 it was 18 per cent and in 2009-10 it was 32 per cent (NWC, 2011b, Table A.3, p.61). Although drought continued to have an influence in 2009-10, water availability was greatly improved that year. In the three years, although the number of dealings decreased in 2009-10, dealings in the amount of water increased, therefore the trading volume per dealings number gradually increased. Also, the average water price fell greatly and was relatively stable in 2009-10 (refer to Figure 13.4).



**Figure 13.4: weekly changes in the average
allocation trade price in the sMDB**

(Source: created from NWC, 2011b, Table A8 and A.9, pp. 63-65)

The water market in our target area operated from 6 August 2009 to 3 June 2010. Supply and demand adjustment of the

water price was carried out during Thursday morning every week and released at noon. So, the data for 42 weeks can be used except for Christmas and New Year holidays.

Section 4: Results

13.4.1: Allocation trading market

We obtained 31 replies about the minimum permissive seller's price (ps_i^s) for each month of the 2009-10 irrigation season.

Similarly, 133 replies were obtained about the maximum permissive buyer's price (pd_j^b) for each month of irrigation season 2009-10.⁶ Forty-one per cent of respondents (=46/112) actually experienced water trading, without distinguishing between selling or buying.

The price data obtained by the questionnaire was compared with the monthly market price. Data that exceeded the market selling price and data that was less than the market purchase price were deleted (refer to Table 13.4). The seller's dealings strike rate averaged 38.2 per cent and the buyer's dealings strike rate averaged 51.8 per cent. In addition, for monthly market

⁶ Our investigation was not able to distribute a questionnaire directory to the irrigation farms for various reasons. Because the questionnaires were distributed through three farming organisations, there is a possibility that the questionnaire to the mixed farming or cropping and grazing farms might not have been fully distributed. It is thought that this deviation explains why there is so little sellers' data compared to buyers' data.

prices, the prices within the same month were weight averaged by volume of the dealings conducted within the same month.

	Au g	Se p	Oct	No v	De c	Jan	Fe b	Ma r	Ap r	Ma y	Tot al
A	1	2	2	2	3	1	2	2	1	0	16
B	0	0	6	11	9	9	7	7	9	8	66

Table 13.4: the number of samples of expected price data after deletion in the allocation trading market

Note: A= The number of succeeded selling price data

B= The number of succeeded buying price data

No selling price data was obtained for May and no purchase price data was obtained in August and September after the deletion of the data exceeding (or being less than) the market price at each month. In that case, it is necessary to use the existing data to estimate the expected price of the people assumed to have completed dealings. The approximated curve was presumed using the existing data and these required data were obtained. The estimation is shown in Figure 13.5.

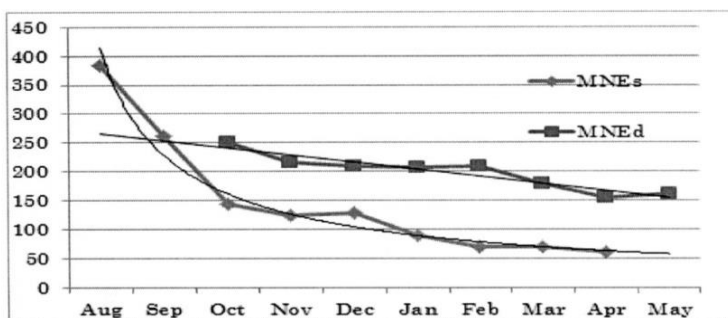


Figure 13.5: estimate of missing data (unit: A\$/ml)

Note: information about an approximated curve: (seller's price)

ln(Y)=6.0292-0.8604*ln(X), Adj.R²=0.9660. MNEs-May (mean) = 57.28

(buyer's price) Y=277.3277-12.1748*X, Adj.R²=0.8600. MNEd-Aug

(mean) = 265.15, MNEd-Sep (mean) = 252.98

As a result, the price in a seller's May was estimated at A\$57.28/ml, and the prices in a buyer's August and September were estimated at A\$265.15/ml and A\$252.98/ml, respectively.⁷

The monthly weight-averaged marginal net earnings ($MNEs$ and $MNEd$, or ps_A^s and pd_A^s) were calculated using the data obtained in this way by making each maximum annual allocation amount of water into a weight. This result was shown in Figure 13.6.

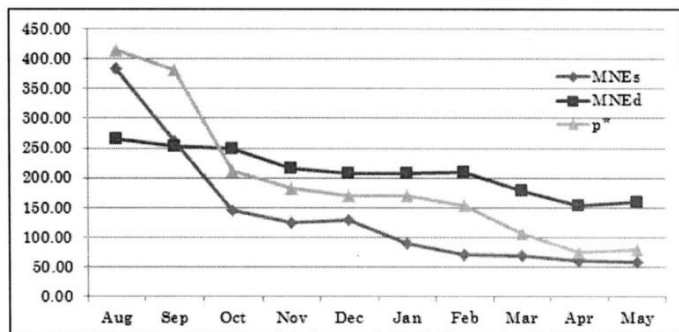


Figure 13.6: estimated MNEs curve, estimated MNEd curve and actual market price (unit: A\$/ml)

The market price exceeded the buyer's expected price level in August and September, with a minus surplus in those months.

⁷ 13.5.3 examines a problem with error.

The seller's expected price was always less than the market price and the seller's surplus was always positive. Although a seller's expected price adapts itself to the market price well, a buyer's expected price is comparatively rigid, mainly around A\$200/ml.

It is thought that the information on MNEs (or ps_M^e) and MNEd (or pd_M^e) expresses the average net earnings of a seller and a buyer at each month. In which case a seller is assumed in general to have acquired average net earnings of around A\$100/ml and a buyer around A\$200/ml.

	Seller's Surplus	Buyer's Surplus	Total Surplus	Seller's %	Buyer's %	Total %	Turnover
Aug	16250.34	-82455.5	-66205.1	7.1%	-36.0%	-28.9%	228924.3
Sep	129963.3	-139222	-9258.57	31.7%	-34.0%	-2.3%	409986.4
Oct	442166.7	254930.8	697097.5	31.7%	18.3%	50.0%	1392837
Nov	320704	183191.8	503895.8	32.0%	18.3%	50.4%	1000670
Dec	199132.6	174187.8	373320.4	25.0%	21.9%	46.8%	797101.3
Jan	726520.3	348470.4	1074991	46.9%	22.5%	69.4%	1549228
Feb	556389.7	373478.6	929868.3	54.5%	36.6%	91.1%	1021246
Mar	224421.8	446989.3	671411.1	34.6%	69.0%	103.6%	647998
Apr	123106.2	671371.9	794478.1	19.6%	106.7%	126.3%	629218.2
May	102845.9	381887.9	484733.8	27.6%	102.5%	130.1%	372583.2
Total	2841501	2612831	5454332	35.3%	32.5%	67.8%	8049792

Table 13.5: monthly economic surplus in the allocation trading market

(unit: A\$, per cent)

Each surplus is calculated as shown in Table 13.5 using the CVM-Trigonometric method from these price data. The result of

the seller's and the buyers surpluses and the total surplus was shown in Figure 13.7 and Figure 13.8.

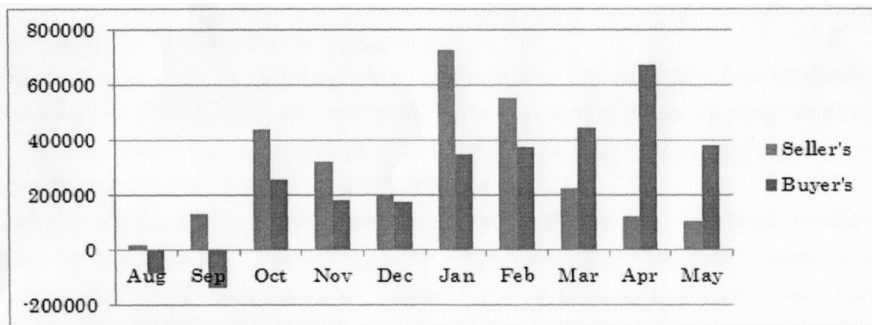


Figure 13.7: seller's surplus and buyer's surplus in zone 1A of 2009-10 (allocation trading market; unit A\$)

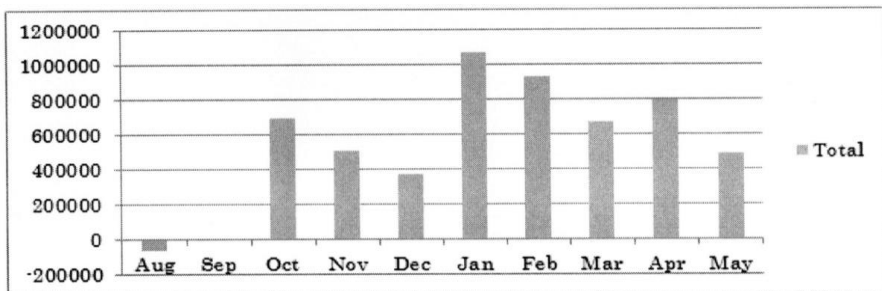


Figure 13.8: total economic surplus in zone 1A of 2009-10 (allocation trading market; unit A\$)

The following can be concluded from these figures.

(1) The average equilibrium price of water market in 2009-10 was A\$150.76/ml, and the equilibrium quantity was 53,393.8ml. The total surplus was A\$5,454,332 and the ratio occupied in the

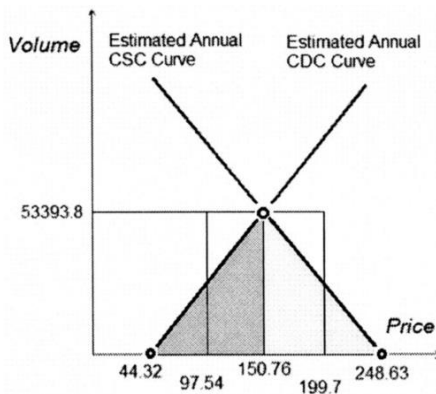
gross transaction amount of money (A\$8,049,792) became 67.8 per cent. Of the total surplus, the seller's surplus was 35.3 per cent and the buyer's surplus was 32.5 per cent.

(2) From the viewpoint of surplus analysis, the irrigation season in the 2009-10 fiscal year is classifiable at three time periods. The first, from August to September, had a negative total surplus. The second, from October to February, had a positive total surplus and the seller's surplus was superior. The third, from March to May, had a positive total surplus and the buyer's surplus was superior.

(3) Counting back from the size of the economic surplus, and estimating the annual CSC curve and annual CDC curve, the Zs point was (44.32, 0), and Zd point was set to (248.63, 0; refer to Figure 13.9). Therefore, the seller's annual average net earnings per 1ml water changed to A\$97.54/ml and the buyer's annual average net earnings per 1ml water changed to A\$199.7/ml. The following interpretations are possible from these figures. In the irrigation season for 2009-10 fiscal year, the irrigation farmer in the area concerned thought that profit was maintained. The seller sold at A\$97.54/ml subjectively, but the water sold at A\$150.76/ml in practice. Moreover, when the buyer could buy it at A\$199.7/ml they generally thought profit was maintained, but water sold at A\$150.76/ml in practice. Therefore, while the seller profited 35.3 per cent ($= (150.76 - 97.54) / 150.76$) on

the market price, the buyer profited 32.5 per cent $(=(199.7 - 150.76) / 150.76)$ on the market price.

The presumed result of annual CSC and a CDC curve (allocation trading market) is shown in Figure 13.9.



**Figure 13.9: illustration of annual CSC and annual CDC
in zone 1A of 2009-10 (allocation trading market)**

13.4.2: Entitlement trading market

When the seller's minimum permissive prices and buyer's maximum permissive prices in the entitlement trading market (high-reliability price) were requested by the questionnaire, nine responses for selling price and four responses for purchase price were obtained. Only a result is shown below for simplicity.

As so little data was obtained, sufficient reliability could not be placed on these values, but if we do assume these were

correct, we can calculate the economic surplus in the entitlement trading market as follows:

	Amount of money(mA\$)	Ratio to turnover (%)
Seller's Surplus	17.31	9.8
Buyer's Surplus	27.83	15.7
Total Economic Surplus	45.15	25.5

Table 13.6: economic surplus in the entitlement trading market in zone1A of 2009-10

Moreover, the Zs point's price and Zd point's price in the entitlement trading market were calculated to be A\$1,718.81/ml and A\$2,806.72/ml, respectively

Section 5: Discussion

13.5.1: Low response rate

Compared to other research findings, it is clear that our response rate of 11.2 per cent is insufficient.⁸ However, it is thought that distribution of respondents' farm type reflects the present situation and our collected reply covers 2 to 4 per cent of the farms of the region in general (refer to Table 13.2 and 13.3). And the price data to which it corresponded on the questionnaire

⁸ For example, the response rate of Wijedasa *et al.*, 2002, is over 30%.

reflect the level of actual market price, as shown in Figure 13.10. The total volume of sales in the sample equates to 2.9 per cent of the actual market, and the total amount of purchase of the sample is equivalent to 17.9 per cent of the actual market (i.e. allocation trading market of zone 1A Greater Goulburn).⁹ Therefore, although the response rate was low, it is thought that the results of the questionnaire reflect reality to some extent. We believe it can at least have meaning as a trial calculation of a CVM-Trigonometric method.

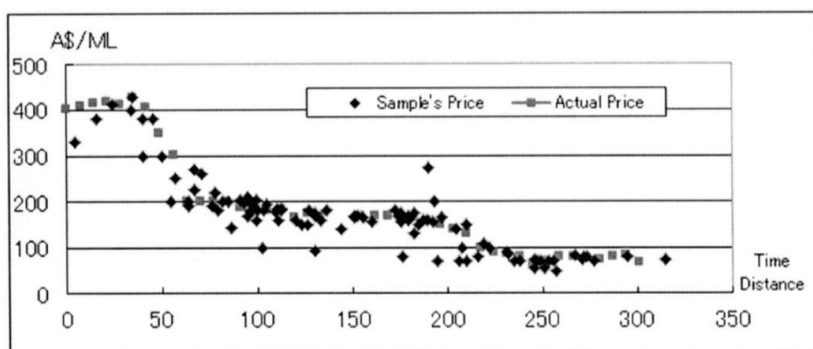


Figure 13.10: the sample's prices and actual prices

13.5.2: The negative surplus

In some of the following cases, our analysis shows a negative surplus occurring. First, for example, is the case of the rice farm that considers net return proceeds of about A\$100-200/ml as marginal when a water price exceeds A\$200/ml as it cannot

⁹ Refer to footnote 6 for the reason the seller's sales ratio is lower than a buyer's purchase ratio.

purchase water (NWC [2010a], p.60). However, when water is available in the early stages of a season, it is thought that a certain amount of loss is expected and sometimes actually produced. It is because the price can some days fall and experience has shown water can be sold at the end of a season (see Figure 13.4).

The second example is when crops need to be maintained over many years as in the case of perennial pasture for dairy farming and perennial horticulture. Here a temporary loss may be accepted in consideration of the maximisation of profits in the more long-term.

In those cases, the jump in price in the early stage of the season is temporary and when water can be sold in the second half of a water season (or can be carried over) the loss may be able to be offset or minimised. Even if the minus surplus is only temporary in such cases, it is not significant if expected profits (π^0) are securable through the whole season (or through several seasons).

Needless to say, the negative surplus does not occur in measurement by the direct method. Thus, measurement by the CVM-Trigonometric method rather than the direct method can better reflect reality when defining the behaviour of irrigation farmers.

13.5.3: Sensitivity test

As our analysis estimated missing data, the result naturally includes error. The seller's surplus and the buyer's surplus were recalculated on the basis of a 95 per cent upper limit and 95 per cent lower limit. Although there are 27 possible combinations, for the sake of simplicity Table 13.9 shows the result of nine cases where both a buyer's August and a buyer's September take a 95 per cent upper limit, a mean value, and a 95 per cent lower limit, and where a seller's May takes a 95 per cent upper limit, a mean value, and a 95 per cent lower limit.

As shown, our estimation result is considerably stable.

		Estimation of the buyer's prices in August and September		
		Both 95%-upper limits	Both means	Both 95%-lower limits
Estimation of the seller's price in May	95%-upper limit	(33.0%, 33.2%)	(33.0%, 32.5%)	(33.0%, 31.7%)
	Mean	(35.3%, 33.2%)	(35.3%, 32.5%)	(35.3%, 31.7%)
	95%-lower limit	(36.7%, 33.2%)	(36.7%, 32.5%)	(36.7%, 31.7%)

Table 13.7: Results of sensitivity test

(Note: the left in a parenthesis shows the seller's surplus to sales, and the right shows a buyer's surplus to sales. The 95 per cent-lower limit, mean and 95 per cent-upper limit of seller's May price were 34.00, 57.28 and 96.52. Each value in a buyer's August and September was 229.71, 265.15, 300.59, 213.05, 252.98 and 292.91)

Section 6: Conclusions

For the first time ever, the economic surplus of a water market was estimated. Simultaneously, the CVM-Trigonometric method was developed as the simple analysis method. As a result, the economic surplus in the allocation trading market of northern Victoria for 2009-10 was estimated at about 67 per cent of the amount of money for dealings. In the case of the entitlement trading market, it was estimated to be about 25 per cent.

Moreover, the seller's annual average of net earnings per 1ml water was estimated at A\$97.54/ml and the buyer's annual average of net earnings per 1ml water was estimated at A\$199.7/ml. Annual price elasticity of supply in the allocation trading market was set to 1.416, and annual price elasticity of demand was set to 1.540.

Finally, in order to consider the meaning of these results, we will make a comparison with the result of other economic effects.

In the NWC report, the trial calculation of the economic effect of the 2008-09 water trading was an increase of A\$220 million in the GDP of Australia and an increase of A\$370 million in the GDP of the sMDB (NWC, 2010a, p.85).

The total amount of dealing of the water market of Australia was A\$1,499.4 million in 2007-08, A\$2,787.2 million in 2008-09 and A\$2,961.9 million in 2009-10.

Supposing that an economic surplus is about 67 per cent of the allocation trading amount and 25 per cent of the entitlement trading amount, and these levels are applicable between 2007-08 and 2009-10, a water market participant's total surplus will be calculated as shown in Table 10. Clearly, the economic surplus effect of water trading is far larger than the 'ratchet effect' of a drought (refer to Table 13.10) .

	2007-08	2008-09	2009-10
The 'ratchet effect' which eases the production reduction by a drought (A) †	191.5~274.8	223.6~370.9	107.2~237.3
Economic surplus effect (B) ‡	771	959	894
Total economic effects (= A+B)	962~1046	1183~1330	1001~1131
The ratio occupied to nominal GDP of the total economic effect	0.081%~0.088%	0.094%~0.106%	0.078%~0.088%

Table 13.8: trial calculation of the economic effects of water trading between 2007-08 and 2009-10 (unit: A\$ million)

(† The data (A) was cited from NWC, 2010a, p.84. ‡ The economic surplus effects (B) are assumed to be 25 per cent and 67 per cent of the volumes of trading of entitlement and allocation trading market respectively)

One interesting result of this paper is that the economic surplus effect may be far larger than a 'ratchet effect'. Therefore when discussing economic effects it is important not to neglect the analysis of the economic surplus effect. Furthermore, we can understand an economic surplus as an index of the size of the potential for participants in the water market. Judging from these figures, it can be said that the Australian water market has possibilities for further development.

If our analysis is considered from a political viewpoint, it can be concluded that if a water price is between A\$97.54/ml and A\$199.7/ml in the allocation trading market, the influence that both seller and buyer have on the community will be small because both the economic surpluses are positive. However, when a water price constantly exceeds A\$199.7/ml, management of some dairy farms and the majority of mixed farms and rice crops becomes severe. Water entitlement trading increases instead of allocation trading and a structural change in irrigation agriculture may take place. These changes will have a potential impact on not only agricultural structures, but also communities. In order to control this, it will be necessary to maintain water prices at A\$200/ml or less (see Appendix Figure 13.7 and average MNE for details).

Although research on the economic effect of water trading is still in its infancy, both the comparative analysis (objective

valuation) by a model and the economic surplus analysis (subjective valuation) are methodologically required. Since economic surplus analysis cannot take place with the data observed directly, the questionnaire survey is indispensable. Although our analysis had a low response rate, we think it showed that economic surplus analysis using the CVM-Trigonometric method is indispensable and can be performed in a water market.

Appendix to Chapter 13

The CVM-Trigonometric Method

1. Minimum Permissive Seller's Price and Maximum Permissive Buyer's Price

Here we will assume that price and volume are determined in the water market. A seller who sets up a price below the equilibrium price, and a buyer who sets up a price greater than the equilibrium price can trade water. The successful order set can be written as follows (see Section 3 of Chapter 5).

$$\text{Successful seller's order set } (SE_{\text{Seller}}) = \{ps_i \leq p^* | E_{\text{Seller}}\}$$

$$\text{Successful seller's order set } (SE_{\text{Buyer}}) = \{pd_j \geq p^* | E_{\text{Buyer}}\}.$$

Next, each seller who had successful dealings will consider how much the water should be sold for before participating in a water market. Although there may be many price setups, there is a minimum price a seller will consider in exchange for a fixed amount of water. This will be called the '**minimum permissive seller's price**' or '**minimum willingness-to-sell price**' (ps_i^e ; $i=1, 2, \dots, k$).

Similarly, each buyer who had successful dealings will consider how much the water should be purchased for before participating in a water market. Although there may be many price setups, there is a maximum level a buyer will consider in

exchange for a fixed amount of water. This will be called the ‘**maximum permissive buyer’s price**’ or ‘**maximum willingness-to-buy price**’ (pd_j^e ; $j=1, 2, \dots, l$).

Minimum permissive seller’s price (ps_i^e) and maximum permissive buyer’s price (pd_j^e) defined here may differ from the actual price shown in the water market, i.e. ps_i and pd_j . So both will be distinguished as a different concept. Moreover, in order to avoid complication, ps_i^e and pd_j^e may be called an ‘**expected price**’.

Here is an example. It is assumed that a certain farmer’s net return per ml is A\$500. In this case, even if this farmer pays a maximum of A\$500 to purchase 1ml of water, a loss does not arise. However, the price this farmer shows to the market is A\$250, when last year’s water price and/or in the previous term is A\$200. In this example, although the maximum permitted price is A\$500, the offer shown to the market is A\$250.

2. Definition of economic surplus

The economic surplus of seller i and the economic surplus of buyer j can be defined under the above setup as follows:

Economic surplus of seller $i = (p^* - ps_i^e) \times s_i$,

Economic surplus of buyer $j = (pd_j^e - p^*) \times b_j$,

Where

p^* : market equilibrium price

ps_i^e : minimum permissive seller's price

pd_j^e : maximum permissive buyer's price

s_i : dealing volume of seller i

b_j : dealing volume of buyer j .

Therefore, the economic surpluses of the seller and buyer who participated in the water market concerned are:

$$\begin{aligned} \text{Total seller's surplus} &= \Sigma(p^* - ps_i^e) \cdot s_i, \\ i &\in (ps_i^e, s_i) \in \overline{SESeller}, \end{aligned}$$

$$\begin{aligned} \text{Total buyer's surplus} &= \Sigma(pd_j^e - p^*) \cdot b_j, \\ j &\in (pd_j^e, b_j) \in \overline{SEBuyer}, \end{aligned}$$

where $\overline{SESeller}$ is the set that replaced price ingredient ps_i of the $SESeller$ set with ps_i^e , and similarly the $\overline{SEBuyer}$ replaced the price ingredient pd_j of the $SEBuyer$ set with pd_j^e .

Here, an interesting theorem will be shown.

Theorem:

$$\text{Total seller's surplus} = \Sigma(p^* - ps_i^e) \cdot s_i = \Sigma \Delta ps_i^e \cdot c_i,$$

$$\text{Total buyer's surplus} = \Sigma(pd_j^e - p^*) \cdot b_j = \Sigma \Delta pd_j^e \cdot d_j$$

is realised.

$$\text{Where } c_i = s_1 + s_2 + \dots + s_{i-1}, d_j = b_1 + b_2 + \dots + b_{j-1},$$

$$i \in (ps_i^e, s_i) \in \overline{SESeller} \text{ and } j \in (pd_j^e, b_j) \in \overline{SEBuyer}.$$

Proof:

Since it is formally the same, only the case of a seller surplus is shown.

It is assumed that $p^* = ps_k^e$. (Also in $p^* = ps_k^e + \alpha$, it is formally the same).

If cautious of

$$p^* - ps_i^e = ps_k^e - ps_i^e = (ps_k^e - ps_{k-1}^e) + (ps_{k-1}^e - ps_{k-2}^e) + \dots$$

$+ (ps_{i-1}^e - ps_i^e)$ being realised, then total seller's surplus will

become:

$$\begin{aligned} \text{Total seller's surplus} &= \Sigma(p^* - ps_i^e) \cdot s_i \\ &= (p^* - ps_1^e) \cdot s_1 + (p^* - ps_2^e) \cdot s_2 + (p^* - ps_3^e) \cdot s_3 + \\ &\quad \dots + (p^* - ps_k^e) \cdot s_k \\ &= \{(p^* - ps_{k-1}^e) + (ps_{k-1}^e - ps_{k-2}^e) + (ps_{k-2}^e - ps_{k-3}^e) + \\ &\quad \dots + (ps_2^e - ps_1^e)\} \cdot s_1 \\ &\quad + \{(p^* - ps_{k-1}^e) + (ps_{k-1}^e - ps_{k-2}^e) + (ps_{k-2}^e - ps_{k-3}^e) + \\ &\quad \dots + (ps_3^e - ps_2^e)\} \cdot s_2 \\ &\quad + \{(p^* - ps_{k-1}^e) + (ps_{k-1}^e - ps_{k-2}^e) + (ps_{k-2}^e - ps_{k-3}^e) + \\ &\quad \dots + (ps_4^e - ps_3^e)\} \cdot s_3 \\ &\quad \dots \\ &\quad + \{(p^* - ps_{k-1}^e)\} \cdot s_{k-1} \end{aligned}$$

$$+(p^* - ps_k^s) \cdot s_k.$$

Since the last clause is $p^* = ps_k^s$ by assumption, the last clause becomes zero. (In $p^* = ps_k^s + \alpha$, the last clause becomes $\alpha \cdot c_k$)

Therefore, the total seller's surplus is

$$\begin{aligned} &= (p^* - ps_{k-1}^s) \cdot (s_1 + s_2 + \dots + s_{k-1}) + (ps_{k-1}^s - ps_{k-2}^s) \cdot (s_1 \\ &\quad + s_2 + \dots + s_{k-2}) + \dots + (ps_2^s - ps_1^s) \cdot s_1 \\ &= \Delta ps_k^s \cdot c_k + \Delta ps_{k-1}^s \cdot c_{k-1} + \Delta ps_{k-2}^s \cdot c_{k-2} + \dots \\ &\quad + \Delta ps_1^s \cdot c_1. \end{aligned}$$

However, if cautious of $p^* = ps_k^s$ being realised, $\Delta ps_k^s \cdot c_k = 0$ will be realised.

(In $p^* = ps_k^s + \alpha$, $\Delta ps_k^s \cdot c_k$ becomes $\alpha \cdot c_k$). Therefore, total seller's surplus $= \sum (p^* - ps_i^s) \cdot s_i = \sum \Delta ps_i^s \cdot c_i$ will be realised.

(QED)

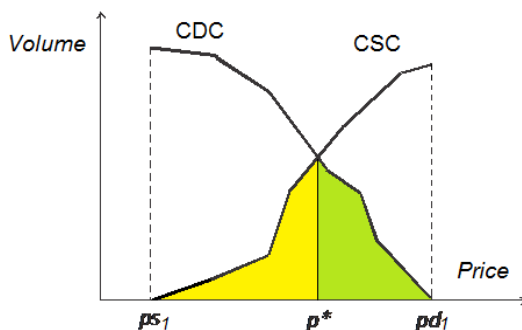
This theorem shows there are the two methods for calculating an economic surplus:

- (1) The calculation method that calculates the surplus of each seller and buyer
- (2) The calculation method that uses a CSC curve and a CDC curve.

That is, the domain (shadowed domain of Appendix Figure 13.1) below the equilibrium price by which the seller surplus was inserted into CSC and the price axis and the buyer surplus

should equal the domain (shadowed domain of Appendix Figure 13.1) more than the equilibrium price inserted into CDC and the price axis.

Therefore, it comes back to the problem that calculation of an economic surplus presumes a CSC curve and a CDC curve.



Appendix Figure 13.1: economic surplus, CSC and CDC

3. Water Market Performances of northern Victoria for 2009/10

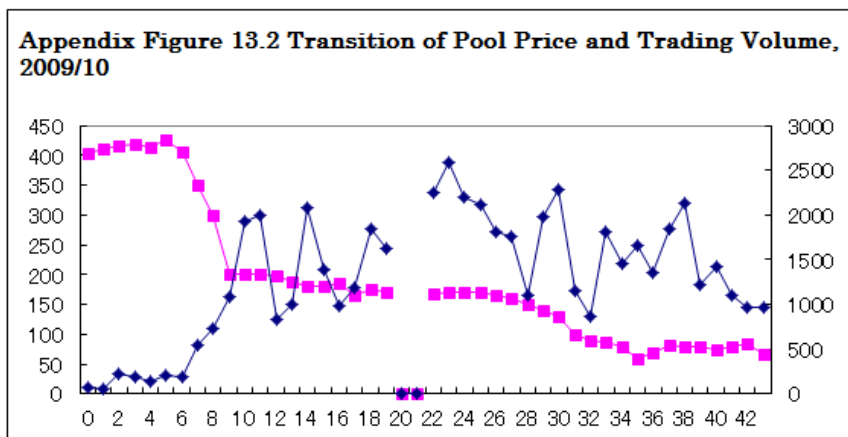
The water market in the irrigation period of the 2009-2010 fiscal year (2009/10) was set up in northern Victoria in zone 1A through Watermove.

The water market operated from 6 August 2009 to 3 June 2010. Supply and demand adjustment of the water price was carried out every Thursday morning and released at noon. Although the above-mentioned period went for 44 weeks, the market was stopped between 24 and 31 December 2009 (Christmas and New Year vacation). So, 42 weeks of data were collected.

6 August 2009 is designated as day zero, and the days or the number of weeks from the day will be called '**time distance**'. For example, the time distance measured by days on 13 August 2009 is 7 (it is 1 measured for the number of weeks). Moreover, the time distance on 3 June 2010 is set to 301 when measuring with the number of days (it is 43 when measured for the number of weeks).

We wish now to examine the transition of the market equilibrium price (called the 'pool price') in the irrigation period concerned, and the trading volume (refer to Appendix Figure 13.2).

Although there was a point at which the price was high in August (the end of winter) in the early stages of the irrigation season, at the beginning of spring in September the price plunged and was comparatively stable for five months (from spring to summer) after that. The price fell further towards the end of the irrigation season (in autumn). The minimum price fluctuated around A\$60/ml on 8 April 2010 (the 35th week) and the peak price fluctuated around A\$427.5 /ml on 10 September 2009 (the 5th week). Trading volume changed from 62ml on 13 August 2009 (the 1st week) to 2585.1ml on 14 January 2010 (the 23rd week). Water market dealings were performed actively from spring to summer.



**Appendix Figure 13.2: transition of pool
price and trading volume, 2009/10**

(Source: based on Watermove data accessed 10 August 2011)

4. Dealings Strike Rate

Next, the **dealings strike rate** is defined as follows:

Seller's dealings strike rate = the number of a seller's orders with dealings realised / the number of a seller's orders,

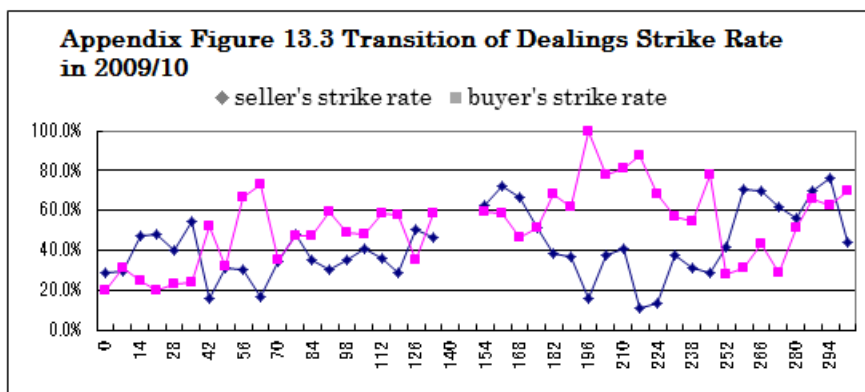
Buyer's dealings strike rate = the number of the buyer's orders with dealings realised / the number of a buyer's orders.

The dealings by which some water quantity was reduced are also dealings realised.

For example, the dealings strike rate of the seller on 28 January 2010 was 51.6 per cent (=47/91). Similarly, the buyer's dealings strike rate was 51.6 per cent (=31/60). The dealings strike rate of the seller on 6 May 2010 was 61.7 per

cent ($=29/47$). Similarly, the buyer's dealings strike rate was 28.5 per cent ($=10/35$).

For one transaction participant, the selling order was 82 offerings and the buying order was 39 offerings when seen with the annual average. The successful selling order per annual average was 31 offerings and the successful buying order per annual average was 20 offerings, respectively. The seller's dealings strike rate was 38.2 per cent and the buyer's dealings strike rate was 51.8 per cent in 2009/10 (transition of the dealings strike rate in 2009/10 is shown in Appendix Figure 13.3).



Appendix Figure 13.3: transition of dealings strike rate in 2009/10

(Source: based on Watermove data accessed 10 August 2011)

As shown in Appendix Figure 13.3, the dealings strike rate has changed considerably over time. Overall the seller failed to sell on about 60 per cent of occasions while the buyer failed to buy on about 50 per cent of occasions.

5. CVM-Trigonometric method

We propose the use of the Contingent Valuation Method (CVM)-Trigonometric method instead of the direct method (refer to 13.2.3 for details of direct method).

According to our hypothesis, aside from the price actually shown in the water market each time, there exist various minimum permissive seller's prices for i (ps_i^e) and maximum permissive buyer's prices for j (pd_j^e) that are equal to the marginal net earnings of each farmer. If this information is acquired, as the theorem in Section 2 of this appendix discussed, a surplus is calculable using a $\overline{SESelle}$ set and $\overline{SEBuyer}$ set.

Next, consider expressing this surplus using three points, one point $(Z, 0)$ on the p-axis and equilibrium position (p^*, x^*) , and an equilibrium price point $(p^*, 0)$ on the p-axis. Because the argument is parallel, it explains a seller's case.

$ps_k^e = p^*$ will be realised if k is made into the number of the seller who succeeded in dealings. Here, p_{sk}^e is the expected price of seller k and p^* is an equilibrium price. When s_i is made into the quantity seller i sold, equilibrium quantity x^* is equal to $s_1 + s_2 + \dots + s_k$.

Now, for the definition of Zs,

$$\begin{aligned}
\text{Seller's surplus} &= s_1(ps_2^e - ps_1^e) + (s_1 + s_2)(ps_3^e - ps_2^e) + \cdots \\
&\quad + (s_1 + s_2 + \cdots + s_{k-1})(ps_k^e - ps_{k-1}^e) \\
&= (p^* - Z_s)(s_1 + s_2 + \cdots + s_k) / 2 \text{-----(1)}
\end{aligned}$$

will be realised. Here, Z_s is a price level required in order to calculate a seller's surplus.

If a formula (1) is divided by $(s_1 + s_2 + \cdots + s_k)$ and it is expressed as $\xi_i = s_i / (s_1 + s_2 + \cdots + s_k) (i = 1, 2, \cdots, k)$,

$$\begin{aligned}
Z_s &= 2ps_1^e \cdot \xi_1 + 2ps_2^e \cdot \xi_2 + \cdots + 2ps_{k-1}^e \cdot \xi_{k-1} \\
&\quad - 2ps_k^e (\xi_1 + \cdots + \xi_{k-1}) + p^* \\
&= 2ps_1^e \cdot \xi_1 + 2ps_2^e \cdot \xi_2 + \cdots + 2ps_{k-1}^e \cdot \xi_{k-1} \\
&\quad - 2ps_k^e (1 - \xi_k) + p^* \\
&= ps_1^e \cdot 2\xi_1 + ps_2^e \cdot 2\xi_2 + \cdots + ps_{k-1}^e \cdot 2\xi_{k-1} \\
&\quad - ps_k^e (1 - 2\xi_k) \text{-----(2)}
\end{aligned}$$

will be obtained.

If a seller's expected price information and the information about the quantity dealings can be obtained, it is clear from a formula (2) for Z_s to be calculated.

Also, as it is set to $1 - 2\xi_k > 0$ in the case of $\xi_k < 0.5$, it will be aware from Z_s that it may become a negative value.

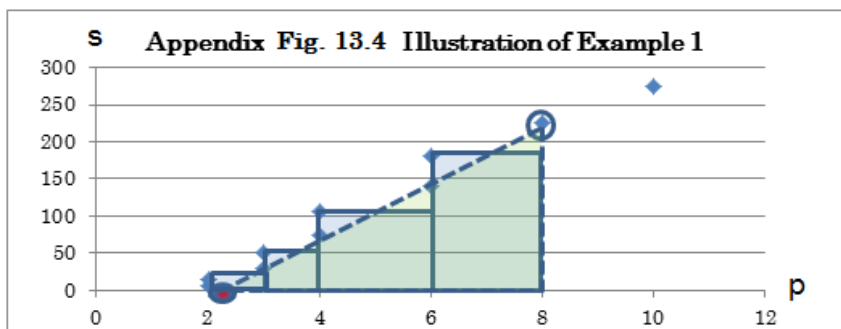
Example 1:

SESeller set is made into $\{ (2, s_1) , (2, s_2) , (3, s_3) ,$

$(3, s_4)$, $(4, s_5)$, $(4, s_6)$, $(6, s_7)$, $(6, s_8)$, $(8, s_9)$, $(10, s_{10})$ }. If an equilibrium price is set to 8, the 10th seller will not succeed in dealings and a surplus will not occur. So, the number of the sellers who succeeded in dealings is $k=9$.

Trading volume is set to $s_1=5$, $s_2=10$, $s_3=15$, $s_4=20$, $s_5=25$, $s_6=30$, $s_7=35$, $s_8=40$, and $s_9=45$. Therefore, the equilibrium quantity is set to $x^*=s_1+s_2+\dots+s_9=225$. A seller surplus is set to 635 and Z_s changes to 2.35. Distribution of the dealings amount of water is $(\xi_i)=(0.022, 0.044, 0.067, 0.089, 0.111, 0.133, 0.156, 0.178, 0.20)$. ■

Appendix Figure 13.4 illustrates the CSC curve of this case and the situation of Z_s . The ratio of dealings amount of water increases as the price approaches an equilibrium and a CSC curve increases gradually. In this case, the possibility of Z_d of becoming an inner point of the section $[ps_1^s, p^*]$ is high (see Appendix Figure 13.4).

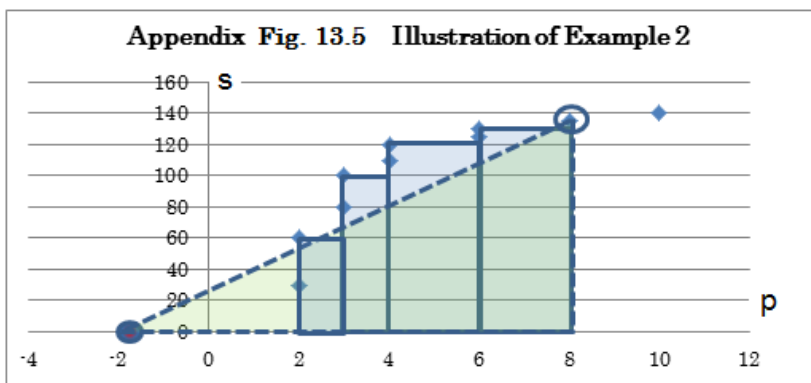


(Appendix Figure 13.4: illustration of Example 1)

Example 2:

Example 2 reverses the distribution of the dealings amount of water of Example 1. Distribution (ξ_i) of dealings quantity was set to (0.2142, 0.2142, 0.1428, 0.1428, 0.0714, 0.0714, 0.0357, 0.0357) to the price (2, 2, 3, 3, 4, 4, 6, 6, 8). In this case, it is set to $Z_s = -1.778$ and the seller total surplus = 660. ■

Appendix Figure 13.5 illustrates the CSC curve of Example 2 and the situation of Z_s . In this case, the CSC curve decreases gradually and the possibility of Z_s of becoming a point outside the section $[ps_1^s, p^*]$ is high (see Appendix Figure 13.5).



Our concern now is how to discover Z_s from the observed data. The distribution (ξ_i) which made the dealings amount of water a weighted value is considered a key for that. In addition, $\xi_k < 0.5$ is assumed in the following arguments.

$$S_k = ps_1^s \cdot \xi_1 + ps_2^s \cdot \xi_2 + \cdots + ps_k^s \cdot \xi_k,$$

from a formula (2), then

$$(Z_s + p^*) / 2 = S_k \text{ or } Z_s = 2 \cdot S_k - p^* \text{ -----(3)}$$

is obtained.

(In the case of a buyer, a formula (3) becomes $Z_d = 2 \cdot D_k - p^*$. Here, Z_d is a price level on the p-axis that is required in order to calculate a buyer surplus. And, $D_k = pd_1^g \cdot \xi_1 + pd_2^g \cdot \xi_2 + \dots + pd_k^g \cdot \xi_k$, $\xi_i = b_i / (b_1 + b_2 + \dots + b_k)$, $i = 1, 2, \dots, k$).

From a formula (3), S_k can be doubled and Z_s can be calculated by the method of subtracting the equilibrium price p^* from there.

Example 3:

If Example 1 is used, since it is $S_k = 5.1778$ and $p^* = 8$, it will be set to $Z_s = 2.356$ from a formula (3). ■

Although the method of a formula (3) is very easy, the problem of this method is whether the information about the dealings amount of water can be fully determined by questionnaires. And the when dealings amount of water cannot be determined, what kind of proxy variable should we use?

It will be comparatively easy to answer for questionnaire respondents, as an expected price is fundamentally dependent on anticipated average earnings or anticipated marginal returns. On

the other hand, the dealings amount of water varies greatly because of natural factors, such as the occasional drought and the growth situation of crops. Also, the time when water dealings are actually conducted differ greatly from the time when questionnaire surveys are conducted. Therefore, it would probably be very complicated to find out in detail about past dealings amounts of water from a questionnaire, and it will also be difficult in practice. (Sk will be calculable supposing past electronic dealings data are usable).

So we would like to propose using the **maximum annual allocation amount of water** of each irrigation farm as a proxy variable of the dealings amount of water. This is because data about the maximum annual allocation amount of water can clearly be obtained more easily than data about the dealings amount of water at each time, and both are considered to have a fixed relevance.

The dealings amount of water of the irrigation farmer i is set to x_i and maximum annual allocation amount of water is set to y_i , and also set $\xi_i = x_i / \sum x_i$ and $\theta_i = y_i / \sum y_i$ ($i = 1, 2, \dots, k$), and the distribution which makes them a coefficient (ξ_i) and

(θ_i) is considered. Our problem is whether we may consider the sum of products: $Sk' = ps_1^e \cdot \theta_1 + ps_2^e \cdot \theta_2 + \dots + ps_k^e \cdot \theta_k$ to

be an approximate value of the sum of products: $S_k = ps_1^g \cdot \xi_1 + ps_2^g \cdot \xi_2 + \dots + ps_k^g \cdot \xi_k$.

In order to understand this problem intuitively, we will make an intelligible numerical example.

Dealings person	1 st time	2 nd time	3 rd time	4 th time	θ_i
1	0.4	0.1	0.1	0.1	0.175
2	0.1	0.3	0.1	0.3	0.2
3	0.3	0.4	0.3	0.1	0.275
4	0.2	0.2	0.5	0.5	0.35
Total	1	1	1	1	1

Appendix Table 13.1: example of distributions

Appendix Table 13.1 is a distribution table made so that four horizontal averages might be set to θ_i and also the sum total of θ_i might be set to 1, and so that the vertical sum total may be set to 1. Moreover, each coefficient was created so that 0.5 might not be exceeded and also so that all the members' specific gravity might not become equal.

Next, the expected price at each dealing is set as follows based on the situation of an actual water market. Although the first time had a large variance in the price and this varied in 50 units, the second time was 40, the third time was 30, and it was

assumed that in the fourth the price variance would gradually decrease to 20 units.

Dealings person	1 st time	2 nd time	3 rd time	4 th time
1	400	300	200	100
2	450	340	230	120
3	500	380	260	140
4	550	420	290	160
Variance	3125	2000	1125	500

Appendix Table 13.2: example of expected prices

Appendix Table 13.3 calculated the sum of products using Appendix Table 13.1 and Appendix Table 13.2.

	1 st time	2 nd time	3 rd time	4 th time
Sum of products using virtual distribution (A)	465	368	266	140
Sum of products using θ_i (B)	490	372	254	136
Rate of deviation = (A) / (B)	0.949	0.989	1.047	1.029

Appendix Table 13.3: calculation of sum of products

Both the results and the change are approximated considerably. As for the rate of deviation, a tendency approaching 1 is observed.

The reason is as follows. If it is written as $S_k = P \cdot \xi^T$, $P = (ps_1^e, ps_2^e, \dots, ps_k^e)$, $\xi^T = (\xi_1, \xi_2, \dots, \xi_k)^T$, then S_k expresses one point in the plane that k points of k dimension vector space: $(ps_1^e, 0, \dots, 0), \dots, (0, \dots, 0, ps_k^e)$ make. When (ξ_i) carries out asymptotic to a tendency target at (θ_i) and the variance of the prices at each time is reduced tendentially towards the end of season, as a result, it is thought that $S_k = P \cdot \xi^T$ carries out asymptotic to $S_k' = P \cdot \theta^T$.

The CVM-Trigonometric method we propose has the outstanding advantage that a surplus is calculable by the comparatively simple method of using a questionnaire. However, there is the problem of whether the new distribution (θ_i) made from the maximum annual allocation amount of water may be regarded as a proxy variable of the distribution (ξ_i) of the dealings amount of water on the other hand. In the short term, although the possibility both will deviate greatly cannot be denied, if we view a longer period of time (for example, through the whole irrigation season), both distribution structures will in general be roughly in agreement. Moreover, if the number of participants in a water market increase, a short-term distribution structure increasingly approaches a long-term distribution

structure. When such conditions are fulfilled, as numerical computation showed in Appendix Table 13.3, our method is considered sufficient as a simple method of approximating economic surplus measurement.

If a price level required in order to calculate the seller's surplus at a certain time is set to $ps_z^g(t)$, that is $ps_z^g(t) = Z_s(t)$, and a price level required in order to calculate the buyer's surplus at a certain time is set to $pd_z^g(t)$, that is $pd_z^g(t) = Z_d(t)$, and if we can find out each time's $ps_z^g(t)$ and $pd_z^g(t)$ by a questionnaire and calculation, an economic surplus at the time t is calculable as follows:

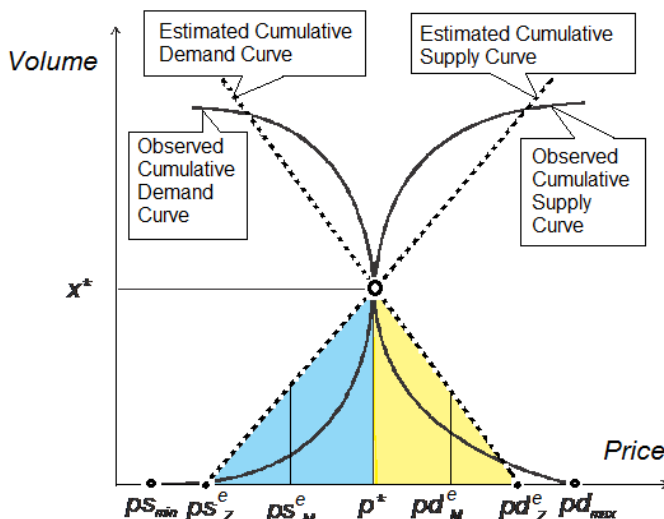
The seller's total surplus at the time t

$$= (p^*(t) - ps_z^g(t)) \times x^*(t) / 2,$$

The buyer's total surplus at the time t

$$= (pd_z^g(t) - p^*(t)) \times x^*(t) / 2.$$

In other words, this means assuming that the CSC curve is a straight line passing along an equilibrium point and a point (Z_s , 0). However, we do not necessarily claim that a true CSC (or CDC) curve is linear (refer to Appendix Fig. 13.6).



Appendix Figure 13.6: illustrated CVM-Trigonometric method

Note: $ps_{min} = \min\{(ps_i) \mid \text{SESeller}\}$, $pd_{max} = \max\{(pd_j) \mid \text{SEBuyer}\}$

Next, we will consider the meaning of ps_z^e , that is Zs.

As the expected price ps_i^e of the seller who succeeded in dealings is equal to the **marginal net earnings** (MNE) for i , the total of all successful sellers' marginal net earnings serves as $\sum MNE_i \cdot x_i$.

If the average marginal net earnings per one unit of water are set to λ , it can be written as $\lambda = \sum MNE_i \cdot x_i / \sum x_i$. Then, if it is written as $\xi_i = x_i / \sum x_i$ ($i = 1, 2, \dots, k$) here, it will become

$$\lambda = \sum MNE_i \cdot \xi_i = \sum ps_i^e \cdot \xi_i = Sk. \text{ -----(4)}$$

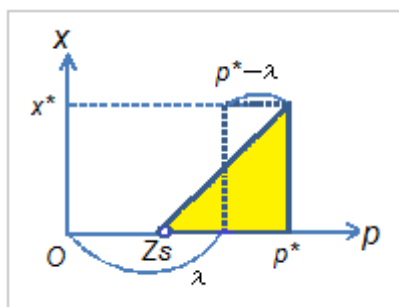
That is, λ becomes equal to that Sk which expresses the average marginal earnings per one unit of water at each time.

Furthermore, from a formula (3), since it becomes $Z_s = 2 \cdot Sk - p^* = 2 \cdot \lambda - p^*$, then

$$(Z_s + p^*) / 2 = \lambda \text{ -----(5)}$$

is obtained.

This shows that λ becomes the middle point between Z_s -point: $(Z_s, 0)$ and p^* -point: $(p^*, 0)$ exactly. Appendix Figure 13.7 illustrates this situation.



Appendix Figure 13.7: geometrical meaning of Z_s

Since $p^* - \lambda$ shows the size of the average surplus that can be gained with one unit of water, what multiplied this by equilibrium output x^* and was divided by 2 becomes equal to the total seller's surplus, so that clearly from Appendix Figure 13.7. Thus, Sk , which is needed in the process by which Z_s is calculated, has given very important information. It shows the

average marginal net earnings (average MNE) of the seller who succeeded in water dealings. In other words, calculation of Z_s means calculating the average MNE of the seller of each water dealing. The information on average MNE will be useful for analysis of a water market.

Finally, the relation between the surplus analysis by CVM-Trigonometric method and the surplus analysis by the direct method is as follows:

When the seller's expected price at a certain time $ps_z^e(t)$ is compared with the minimum seller offer price $ps_{min}(t)$ which the water market demonstrated, since $ps_{min}(t)$ is considered to be strongly linked to the strategic factor for making dealings successful, it is possible that $ps_{min}(t) < ps_z^e(t)$ will rise (refer to Appendix Fig. 13.6). When the buyer's expected price at a certain time $pd_z^e(t)$ is compared with the maximum buyer offer price $pd_{max}(t)$ observed in the water market, it is possible that $pd_z^e(t) < pd_{max}(t)$ will also rise. However, the same does not necessarily hold true for other prices. Therefore, the result of CVM-Trigonometric method is not invariably smaller than the value calculated by the direct method (refer to Appendix Figure 13.6).

So concludes the description of the CVM-Trigonometric method.

The procedure for the surplus calculation at each time in a water market

(#1) Find out about the expected price at each time ($ps_1^e, ps_2^e, \dots, ps_n^e$) and the maximum annual allocation amount of water (y_1, y_2, \dots, y_n) by questionnaire.

(#2) From a water market, the information on (equilibrium price p^* , equilibrium volume x^*) at each dealings time comes to hand.

(#3) Remove the data that made the expected price exceed the equilibrium price from the data set of the annual distribution amount of water.

(The same data as an equilibrium price is included).

(#4) Calculate $\theta_i = y_i / \sum y_i, i = 1, 2, \dots, k$ (k is the number of samples of the sellers who succeeded in dealings) using the data of (#3).

(#5) $Sk' = ps_1^e \cdot \theta_1 + ps_2^e \cdot \theta_2 + \dots + ps_k^e \cdot \theta_k$ is calculated as a proxy of Sk .

(#6) Calculate Zs' according to $Zs' = 2 \cdot Sk' - p^*$.

(#7) Calculate a seller surplus at each time as $(p^* - Zs') \cdot x^* / 2$.

(A buyer's surplus is similarly calculable).

Chapter 14

Conclusions

Section 1: Evaluation of Australia's water market as a new means of water resources management

Water markets determine rights to water that can be used as a resource, and distribute water resources through the free trade of rights between economic players. Water market reform converted the old management system of water resources, based on command and control by the government, into an overall management system that uses market-based instruments, including the water market.

For conventional water resources management to achieve economic growth and respond to increased water demands brought about by urbanisation and an increase in population, it was essential to develop infrastructure through dam construction and other facilities. Management of water resources was left mainly to the constructor (i.e. government) of these infrastructures. In other words, old water resources management was synonymous with when and where a dam is built.

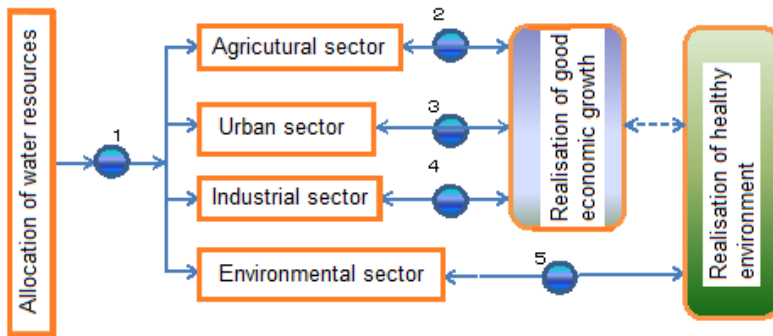


Figure 14.1: global image of water resources management
 (Note: round marks show the need for management by people)

If the global image of water resources management is understood as shown in Figure 14.1, the conventional management system can be said to have the administrative organ manage all the channels from 1 to 5 by command and control.

However, as water resources approached their limit, and increased in water use began to cause various conflicts of interest and environmental degradation, a new system of management was needed. In particular, infrastructure construction lost its cost effectiveness because of the increase in the marginal costs of water, and a cheaper management system was needed. Dissolution of the budget deficit accompanying ‘big government’ and a reform of the public sector were needed after the 1980s.

The new water resources management system was based on the ‘**demand management**’ view that various policy objectives

could be attained by managing demand after setting a supply constant, or redistributing the existing water distribution.

Meanwhile, **integrated water resource management** (or integrated catchment management) was observed as a new style of water resources management, enabling citizens' participation in municipal affairs and making practical use of the market technique for demand control. Integrated water resource management and the market technique are the antithesis to environmental destruction and the inefficiency of cost effectiveness.

Both were distinguished from conventional management systems because the imbalance between supply and demand was not solved by supply expansion, but by optimal management after setting the amount of supply constant or reducing supplies. In this way, mainly from the perspective of cost effectiveness, the water market attracted attention as an effective means of water resources redistribution, and its use and improvement followed.

However, it is probably not realised the extent to which the market technique was used as a means of water resources management in the early 1980s. In the United States and Australia, it was impelled by the reality of drought, and use of the water market progressed in the agricultural sector (i.e. point 2 in Figure 14.1) little by little. However, when the 1990s came,

the limit of water resources and the financial breakdown both became clearer. These factors and public sector reform stressed the need to convert supply management of water resources to demand management.

Through the development of these changes it could be said the water market was introduced into the real world.

Now, we examine the Australian water market. The present condition of the Australian water market can leave the sector of point 2 in Figure 14.1 to the management of the market, and it can be understood as the point at which the market is partially used (or began to be used) in providing water for the environment: 5, and water for cities: 3 (However, a big city does not at present participate). How can we evaluate the Australian experience as a system of new water resources management?

First, we will examine whether the means of water resources management replaced the conventional management system.

Needless to say, the water market cannot increase the total amount of water supply. Neither can it become the alternative to the maintenance management of infrastructure. Therefore, some part of water resources management, i.e. the maintenance management of infrastructure, centring on conventional infrastructure, is required as a premise for new water resources management.

However, when the present water supply system was given, the Australian water market was able to get results utilising the given water resources and producing the greatest economic value (refer to Chapter 12 and Chapter 13 for details). Therefore, experience can be said to have proved that on the whole the Australian water market was effective as a method of water demand management.

Next, have government intervention and budget deficits been reduced? The water market clearly needs tailor-made reform, and the expense of various designs of institutional arrangement, such as the establishment of various legal reforms, registration systems for water entitlements and its transfer, and accounting systems and reservation of the transparency of information. Moreover, various transaction costs need to be reduced to establish efficient water markets. Therefore, the intervention of the government is not lost and, generally, it can be said that the initial investment for starting a water market is large.

However, the nature of government intervention can change greatly. The government can manage the coexistence of the environment and economic activity by incorporating and/or privatising water organisations and establishing new organisations, such as CEWH and CMAs, as an environmental measure (see Chapter 9 and Chapter 12). This also conforms to

the new 21st-century policy concern of securing social sustainability in the future.

When looked at like this, the water market reduced government intervention in water resources management and made it possible for it to pursue a higher order policy concern. For example, the reservation of water for the environment and the creation of the basin plan are proof that governmental financial burdens have been reduced as construction expenses, such as for dams, have become unnecessary and conventional government expenditure for water development was reduced. Furthermore, farm subsidies may also have decreased by the development of a water market and an improvement in farm management (see Section 3 of Chapter 12).

On the other hand, although it is necessary to take the expense of starting the water market and the economic effects of a water market into consideration, looking at it in the long run, it is possible that the initial expenses are sufficiently offset by the growth of new industry and the income relevant to development of the water market. For example, a prominent effect of the water market is that agricultural output increased in spite of drought. Moreover, as calculated in Chapter 13, it is thought that the economic surplus effect for 2007-08 to 2009-10 is quite large and contributes enough economically – about A\$3 billion – for three years.

We can conclude that the Australian water market's new management system is effective as a technique of demand management and also turns a profit economically and financially.

But that is not all. As we have indicated, the water market has a still bigger meaning.

(1) It produces new income and employment. It generated new employment and business expansions, such as water brokers, solicitors, water consultants, environmental managers and increased staff for water delivery organisations. (However, it is unknown whether the water market increased employment as a whole. See Section 3 of Chapter 12). Innovation occurred in the pricing system (tenders, options, forward contracts etc.) in connection with the water market, and software development (i.e. intellectual property rights) and new management systems were produced.

(2) New social structures were created, changing society. The new governmental agencies called CEWH and VEWH were born. Interstate trade, the salinity credit system and The Living Murray projects (including environmental buyback) needed construction and structures extending beyond state borders required unification which in turn affected the integration and reorganisation of the political-administrative system as a nation state. Also COAG's (Council of Australian Governments')

water reform promoted the integration of the federal system and functional specialisation.

(3) Social integration was advanced and contributed to the evolution of a democratic system. A market can reconcile religious and political values to a common measure (i.e. money). Advancing resource allocation by command and control in a social situation with various opposing senses of values will induce much friction. If looked at like this, although the market cannot be said to be perfect, it is at least a solution that is free, flexible and easy to accept. The sense of reliability in the residents' government can be increased, residents' participation can be increased and governmental administrative costs can be reduced. That is, a water market can be democratic and has the ability to reconcile various conflicts of interest, especially for a multicultural society such as Australia.

(4) A water market is not only a way to attain economic efficiency, but is an important instrument for sustainable development. The water market made it easy to reserve water for the environment. Allocating water for the environment can help with environmental regeneration and creates knowledge of timing for the quantity of water indispensable for the environment, or environmental regeneration. That knowledge is systematised and gives us the means for rational decision-making by making a model that considers the greatest effect at

the minimum cost, and with an influence on the world for 100 years or more. That will clear the way for a new coexistence between the environment and economy. The environment may be able to support instead of restrict economic growth. That is, a water market enables society's conversion through environmental reproduction (see Figure 14.2 and Figure 11.9).

The new experience of Australian water resources management shows how efficient water resources management by a market can also become an important key for democratic evolution, the activation of modern society and construction of sustainable society.

Section 2: The Australia model

Let us call the 'Australia model' the result of Australian water market reform over 30 years. So, what is the Australia model anew? Australia took advantage of water market reform to change the relationship between the environment and the economy, and evolve a social system that makes the environment and economy coexist. We would like to understand the Australia model as follows (refer to Figure 14.2):

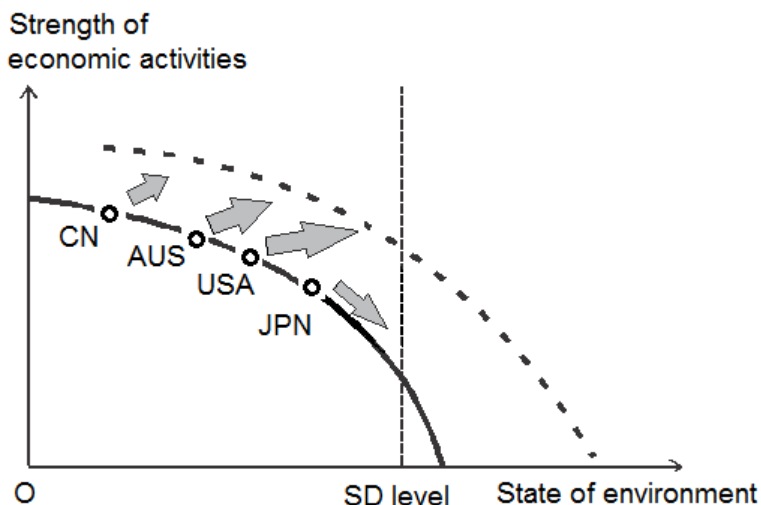
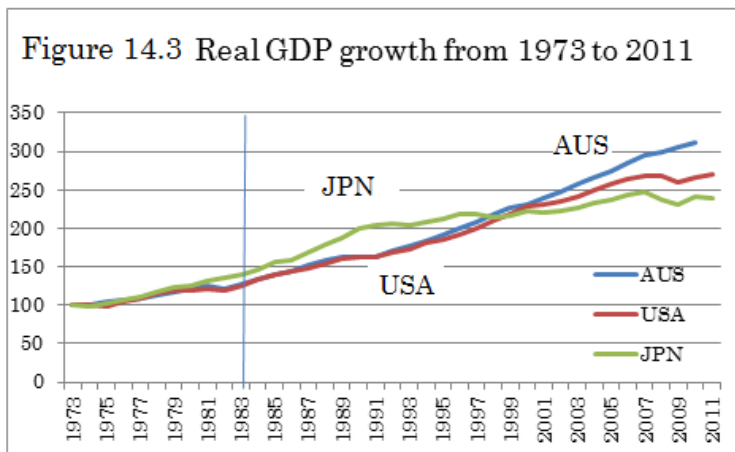


Figure 14.2: illustration of the meaning of the Australia model

The Australia model shifted the conventional economic activity and the environmental relationship to the upper right and expanded the area in which economic growth and environmental preservation are compatible (this process is called social system change. Refer to Figure 2.1). For example, Japan cannot but give up economic growth if it tries to reach a state sustainable with the present environment and economic relations. However, Australia, the United States and China introduce a water market and change positively the relationship between environment and economy. As a result, both higher growth (or continuation of growth) and environmental improvement occur.



(Source: see Figure 7.1)

Figure 14.3 sets Australia, Japan and the USA in 1973 to 100 and compares the growth of the real economy. In 1973 the United States and Japan plunged into the floating exchange rate system, and this happened in Australia in 1983. If we consider the stagnation of the Japanese economy in 1990 and afterwards, and the Japan-Australia inversion in 1998 and especially afterwards, it demonstrates that Japan needs a new growth strategy.

A new growth strategy will need to improve not only the economy, but also the relationship between the environment and the economy. Although the water market is not necessarily the only method for improving relations between the environment and the economy, it is certain that the introduction of a water market is an important tool and an attractive subject of activity

for modern society. As already seen, not only an economic meaning but also a social environmental meaning is applied. Considering that a water market can serve as a tool of social integration while developing democracy, and also activating contemporary capitalism, it should be seen as a key tool with many capabilities, not only one of many means.

(The features of the Australia model)

- The water market serves not only for closed irrigated land divisions but covers dealings exceeding states.
- It is efficient and transaction costs are low, and water markets are made using the internet so that it is easy to participate. As a result, it is a market where participation rates and capacity factors are high.
- It is designed to be especially easy to use the water market at the level of individual irrigation farms. This gave irrigation farms useful management tools and pliability in irrigation agriculture management, especially for risk management. As a result, water reform contributed to strengthening agricultural global competitiveness, and strengthening the autonomous management of farms.

- It introduced big water market and public sector reforms (i.e. ‘corporatisation’) that resonated and involved society as a whole.
- The water market serves as a new means of water resources distribution called water for the environment. Furthermore, it succeeded in building a symbiotic relationship between environment and a water market.
- The market technique is used positively to solve various social-political conflicts, such as the confrontation between the city and farming communities.
- The water market serves as an important means for converting sustainable society.

Section .3: Answers to key questions

Next, we will try to answer key questions first posed in Chapter 1.

(Key Q1) Why and how was the Australian water market successful in this way?

(Answer 1) The factors in which the Australian water market succeeded were summarised in Chapter 12. It is as follows:

- (1) The unitary management system of the water resources by state governments and the efficient water supply organisations (water corporations) existed independently under a decentralised system called the federal system.

- (2) The water distribution organisation has been corporatised through management reform and organisations have been created that support a water market by stabilising and restructuring management, and people's cost consciousness regarding water and irrigation farm management has been changed.
- (3) Farms replaced their method of gaining water mainly through a water market brought about by the introduction of the Cap system and the prolonged drought. Well adapted for such a change, it tackled positively the need for an increase in efficiency and improved management of water use, and was ready for utilising a water market.
- (4) Governments, the MDBC/A and scientists presented clearly the need for various reforms (i.e. practical use of a market system and micro-economic reform for international competition) centring on the foundation of a water market in such a situation. Governments and people were united and tenacious efforts for reform were continued.
- (5) They succeeded in building a flexible system that can optimise the many-sided value of water without being mutually contradictory, especially by the unbundling of water rights and the construction of multi-level and citizens' participation in the municipal affairs-type governance system for integrated catchment management.

The features are high efficiency, low transaction costs, high participating rate, high economic surplus, a symbiotic relationship, sustainability and the cooperation of administration and residents. Stated directly, the Australia model, which succeeded in changing the relationship between economy and environment into a symbiotic relationship, will be regarded as a success story of cooperation between administration and residents.

Australian water reform became something with a big reach. Therefore, although many subjects (or entities) were related and each played an important role, in our view the state government took the initiative. By exposing a conventional problem and limiting it with various water resources managements, the state governments drew the blueprint for reform, led the institutional and legal reform, reformed the water organisations and established the water market, and integrated water resource management. It was the greatest factor in the success. The important aspect of this reform is that they were the bureaucrats responsible for conventional water resources management. It would probably be difficult for them to deny one's own territory and role, or to consider reducing bureaucracy. It would be equally difficult to downsize oneself by restructuring one's

activity. However, the situation of the 1980s called for a major change to reproduce the water industry as a non-public sector. We would like to pay big respects to the stewardship of those who called for this reform as a problem of bureaucracy and pursued self-sacrificing reform (refer to Chapter 7).

Moreover, things that cannot be overlooked as other factors of success are that:

1. Water market reform was interlocked with public sector reform of water supply organisations,
2. There was a mechanism (i.e. MDBC/A) in which there was one big river connecting four states and one territory, called the Murray River, and historically each state cooperated in managing this river,
3. The role of the PC (Productivity Commission) and economics societies (such as Australian Agricultural and Resource Economics Society) supported water market reform as micro reform,
4. There were scientist groups who enabled decisions on various kinds of environmental preservation programs, especially the CSIRO (Commonwealth Scientific and Industrial Research Organisation).

Finally, we think that the diversity of Australian commercial irrigation agriculture is also important.

(Key Q2) What kind of influence did the water market have on society and the environment?

(Answer 2) Section 14.1 of this chapter described this. It was actually shown that the new water resources management using a market can be realized in various restrictions. Furthermore, it contributed to the evolution of modern society (including agricultural independence), democratic evolution and construction of a sustainable society. It showed that under certain conditions a water market and the environment can enjoy a symbiotic relationship.

(Key Q3) What meaning does the Australian experience have for the construction of a sustainable society?

(Answer 3) The economy and environment can be changed into a symbiotic relationship by unbundling water rights and making another organisation, such as CMAs and private sector entities, responsible for efficiency and environment management. Furthermore, the trial of environmental regeneration by water for the environment can strengthen the environment and can clarify the way the environment and economy can coexist in the long-term. Furthermore, the experience of market management

of water resources contributes to the development of new environmental management techniques, such as salinity credits trading, e-flow and etc. and can contribute to the development of a sustainable society.

Section 4: The contribution of this book

We believe this book adds to understanding on the following points:

- For the first time, it analysed and generalised in economic terms Australia's overall water market experiences from a non-resident's viewpoint.
- When a water market was introduced, it was shown clearly whether reform of what kind of subsystems are needed.
- It analysed in detail the interlocking of the demand curve and supply curve for water (Chapter 3).
- It developed a theory covering the expected price of water (Chapter 3).
- The tatonnement process in a water market was analysed theoretically for the first time (Chapter 5).
- It made the first comparative analysis of the water rights of Japan and Australia (Chapter 6).

- The relationship between water assets and the profit of Australia was analysed by using actual data for the first time (Chapter 8).
- The meaning of Australian water market reform was analysed from the viewpoint of water resources management. Not only economics were examined, but also integrated catchment management and its meaning clarified (Chapters 9 to 11).
- It showed that a water market and the environment can be in a symbiotic relationship rather than in a trade-off, and that the purchases that led the environmental flow of the water market are an application of the Coase theorem (Chapter 10 and Chapter 11).
- It clearly showed that a water market has various influences on society has an important meaning for modern society and plays a role in the construction of a sustainable society (Chapter 11 and Chapter 12).
- It showed that a water market is also an important tool of a democratic society, reconciling not only the efficiency of resource allocation but also political confrontation, such as that between the environment and economy and the confrontation between cities and farming communities (Chapter 9 through 11).

- The meaning of the Australia model was analysed from the viewpoint of sustainability (Chapter 11).
- A simple method of measuring the economic surplus of a water market was developed and, in a world first, the economic surplus of the water market was actually measured using this method (Chapter 13).

Section 5: Rich possibilities of a water market

Here, despite some repetition, we gather together and summarise the benefits and opportunities of a water market.

- The first is the expansion of agricultural output under limited water resources if the transaction costs of the water market are low. The greatest level of production during a resource constraint can be attained through re-distributing many resources among the farms where productivity is high. A rise in the level of production has a big effect on the economy through export and other trade. Furthermore, the stability of farm management promotes investment and this further increases global competitiveness and improves self-reliance of agriculture.
- The second is the ability to offer a flexible management option (for example, an asset management option, or a risk management option) for farm management.

- The third is that it may save water or cause technical changes by price indications, such as the development of agricultural technology, that save water and encourage innovation in water-saving industrial techniques. For example, when a water price is set to A\$100/ml, and 10ml of water is purchased, expenditure of A\$1000 is needed. If 10ml of water use can be saved by the investment of A\$1000, the same economic effect as newly purchasing 10ml of water is expected. Thus, a water price can raise the efficiency of technical reform investment.
- The fourth is the founding of new industries including intellectual property rights concerning the water market and employment of water brokers, water consultants and environmental managers.
- The fifth is the improvement of resources and contamination management techniques. Through the success of water markets, the discharge management or resource utilisation techniques may spread to other fields. For example, the market technique may spread to water quality control (emission right trading), bulk garbage management and carbon dioxide emission trading. New techniques such as tenders, forwards and options, have been developed and innovative of resource control techniques have arisen.

- The sixth is the improvement of an administration system or public sector. With a successful water market, the administration system supporting it attains influence in the state which in turn affects administrative decision-making, government intervention and the role of the public sector.
- The seventh is the effect of promoting the practical use of surplus water rights such as ‘sleeping water rights’ and ‘dead water rights’.
- The eighth is a reduction in government intervention costs and government expenditure in connection with infrastructure, such as dams. As a result of this reduction, water resources management can be expanded to a higher level, such as sustainability and involvement in climate change issues.
- The ninth is the realising of democratic evolution and national integration. The water market offers a solution by providing an economic incentive for resolution of clashes between the environment and the economy, and between the city and farming communities. Although there no political process occurs, people are acting in their own best interest, creating desirable distribution as a result. Thus, a democratic and flexible system would probably be difficult without utilising a market.

- The tenth is the improvement of social sustainability. The relationship between the economy and the water market can offer a new means to secure the water for environment, and can lead to a new relationship in which the environment and the economy live together. Environment and economy are converted into a symbiotic relationship from a standoffish relationship through the development of a water market, and social consciousness can be changed through people's participation.

Section 6: The future of the Australian water markets

We would like to describe our expectations about the future of the Australian water market.

The Australian water market has so far accomplished qualitative and quantitative alteration in three dimensions as follows:

- The first axis of coordinates is expansion of the purpose of a water market. This has been expanded from economic efficiency to environmental preservation.
- The second axis of coordinates is expansion of water market dealings from surface running water to groundwater.

- The third is expansion of uncertainty. This has been expanded from a deterministic domain to an uncertainty domain including risk management.

Therefore, it is thought that the future development of the water market will follow a similar direction. It is certain its future management presents a very difficult problem. For example, unifying groundwater in a water market probably needs considerable scientific knowledge and experience (adaptive management). Moreover, natural changes such as extreme drought and heavy rain due to global warming probably require the development of further risk-management techniques, such as the introduction of an option technique or a risk premium (especially for water corporations).

Next, we discuss how a water market is refined. For example, the high use situation of 90 per cent of River Murray water is too high to maintain a natural flow. Although the basin plan aims at solving this problem, how far the superfluous river capacity factors of the MDB can be lowered is a big challenge, testing the limits of scientific knowledge and environmental regeneration. The superfluous issue of water rights will also pose a problem. Publishing water rights with high reliability by basing them on a long-term stable supply level will stabilise its collateral value (see Section 3 of Chapter 12) and will be

another important issue facing the development of a future water market. Moreover, the problem of gathering the participating rate (it is about 40 per cent now) to a water market, and how to further reduce transaction costs are issues still needing to be pursued. It is also important to raise the dealings strike rate of a water market.

Next, there is the problem of whether to allocate water resources that embrace water for cities or water for the environment. Roughly, under present circumstances, the price of the water for irrigation is about A\$16/ml. When capital reduction is carried out at 6 per cent of interest rates, it will change to A\$266/ml (see footnote 2 about the inquiry survey in 8.1.3, Chapter 8) and water for cities will be A\$1000/ml (see Example 3, Chapter 8) and water for the environment or water for irrigation will be A\$1700/ml (see NWC, 2011a, p.85). This shows that there is no common market among these three sectors. However, supposing society leaves distribution of water resources to a market, should not the water market for environment, for agriculture and for city be unified into one? (Namely, a society should aim at a state that has established a common water market containing all the sectors of 1–5 of Figure 14.1). When one unit of water in the economic sector and one unit of water in the environmental sector have a common value, the optimum allocation of water resources to the

environment and economy is achieved. Looked at like this, it is possible that the Australian water market is on the threshold of integrating the economic and environmental values of water. Next, it seems that the internationalisation of a water market occurs. There are two sides in the internationalisation of a water market: the internationalisation of the Australia model and the internationalisation of a water market. Regarding the latter, if world-wide shortages and mis-distribution of water resources arise from now on, and transportation costs fall dramatically, internationalisation of a water market may occur. The entry of overseas capital into the water market makes us have a presentiment of such a change. It is expected that Australia will play a leading role in the internationalisation of the water market. The mis-distribution of water resources and its correspondence to global warming are difficult subjects for only one country. Therefore an international water market, guidelines on water trading, and cooperative organisation will probably also need to be built.

If people's knowledge can be concentrated and a water market can be built on an international scale, it would become possible for it to develop simultaneously to correspond to global warming, or to global water shortages to pursue economic growth. Australia is expected to make a big contribution in such a field.

On the topic of former internationalisation, we can profit by learning from the experience of Australia. But can Australia's experience be generalised as a global standard model for integrated water resources management?

It is certain that the peculiarity of Australia colours and serves as the backdrop for Australian water reform, and for water market reform. Australia is unique due to several factors:

- the natural singularity of Australia,
- people's ardent love of environmental preservation,
- the diversity of values as a multicultural state,
- the decentralised-authority system of the federation and states,
- long tradition of two major-party political system and citizens' participation in municipal affairs.

However, we do not emphasise such peculiarities. It is possible from Australian experiences to generalise:

- efficient redistribution means of water resources,
- means to overcome the general conflict of interest between the economy and environment,
- social system changes that result in a sustainable society.

Water market reform has a big influence on the structure of the existing society. Starting one requires huge capital

investment. However, we can learn from the experience of Australia. By benefiting from its experience and taking lessons from Australia, other countries will be able to move forward in maintaining a social system with comparatively cheap initial investment. Global warming has already affected the weather and water resources. We should not rule out that a water market could be adapted for a future environmental risk and to aim for the realisation of a simultaneously rich and fair society. The experience of Australia gives us great courage and hope, and knowledge of our common sustainable future.

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